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(*Recognosce notum, ignotum inspice*)

TRANSACTIONS

Edited by

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THE BETTWS-Y-COED FORAY.

September 22nd to 27th, 1924.

THE twenty-eighth Autumn Foray and Annual General Meeting was held at Bettws-y-Coed, North Wales, from Monday, September 22nd to Saturday, September 27th, with head-quarters at the Royal Oak Hotel.

Some of the party, who had arrived for the previous week-end, had already collected a number of interesting species, which were set out in the billiard-room of the hotel. Among these were *Hypholoma catarium* and *Pleurotus geogenius*, both of which were subsequently found to be abundant on several large old sawdust heaps in the neighbourhood. Miss Eyre brought in *Hygrophorus metapodius*, and later in the week Miss Noel secured *Gyroporus cyanescens* in the immediate neighbourhood.

The exhibits were added to by Mr E. M. Day, who had brought from the neighbourhood of Minchinhampton, Gloucestershire, *Clavaria aurea* and *C. formosa*, *Collybia fumosa*, *Hygrophorus pudorinus*, *Cortinarius* (*Phlegmacium*) *turmalis*, *cyanopus*, *infractus*, *caesio-cyaneus*, *testaceus*, *C.* (*Dermocybe*) *anomalus* and *C.* (*Hydrocybe*) *subferrugineus*. Miss Wakefield showed specimens of *Boletus rubinus* W. G. Sm. collected at Kew, and Mr Sharpe, who, unfortunately, was unable to be present, sent *Xylaria polymorpha*.

The first day's hunting (Tuesday) was considerably spoilt by the weather, which was bad enough to daunt even some of those accustomed to mycological forays. The hardier spirits, however, stayed out the day, and brought in a fair number of records. The ground worked included coniferous woods at Gwydr Park, and mixed woods near Llanrwst. Among the more noteworthy finds were *Trichoglossum hirsutum*, *Hygrophorus irrigatus*, *H. nitratus*, *Cortinarius bolaris*, *C. croceoconus*, and fine specimens of *Tremellodon gelatinosum*.

In the evening, at 9 o'clock, the Annual General Meeting was held, the chief business being the election of officers and Council and consideration of locality for the 1925 Autumn Foray. Mr Cheesman was elected President for 1925, Miss Lister Vice-President, and Mr Paulson and Mr F. A. Mason members of Council. The other officers were re-elected. On the proposal of the President, Miss Gulielma Lister and Miss Annie Lorrain Smith were elected Honorary Members.

The Secretary read a letter she had received from Dr Paul A. Murphy, conveying a very warm invitation from Irish botanists to hold the Autumn Foray in Ireland in either 1925 or 1926.

After some discussion it was decided to accept the invitation and to arrange the Foray for 1925 if possible.

Mr Ramsbottom reported the purchase of the late Sir Henry Hawley's copy of Cooke's *Illustrations of British Fungi* for the library, and these and the other books already acquired were set out in the meeting-room for the use of members.

Following this Dr Wager gave a short paper on "An Aldehyde Reaction in the tissues of Fungi."

On the Wednesday, starting at noon, Bronrhedyn and Hafod Woods, on the Denbighshire side of the Conway, were visited. At the outset numerous specimens of *Xylaria carpophila* were found growing on old beech mast. A Pyrenomycete collected on a standing dead hazel stem proved to be *Cryptospora corylina*. On the whole the finds were noteworthy for quality rather than quantity. *Scleroderma Geaster, Boletus piperatus, Clavaria umbrinella, Lepiota seminuda, Tricholoma album, resplendens, saponaceum, militare, Hygrophorus laetus, miniatus, Cortinarius impennis, erythropus, spilomeus, Cordyceps ophioglossoides, C. capitata* and *C. Forquignonii* were amongst those recorded.

In the evening, at 9 o'clock, Mr Ramsbottom delivered his Presidential Address on "The Taxonomy of Fungi." Resolutions of congratulation were passed for conveyance to the French Mycological Society on the occasion of its fortieth anniversary and the School Nature Study Union on its coming of age.

On Thursday, September 25th, some mixed woods along the river between Miner's Bridge and the Swallow Falls, and beyond, were visited, while a few members of the party climbed the hill above and worked the moor land there, where *Ramsbottomia lamprosporoides* was found. Some time was spent at the outset on the large sawdust heap at Miner's Bridge, where, in addition to the two species mentioned above, were also found *Flammula sapinea, Paxillus panuoides, P. atrotomentosus, Crepidotus mollis* and several Mycetozoa, as well as some other species less characteristic of sawdust. The woods yielded *Cortinarius phoeniceus, Inocybe Godeyi, hystrix, Pluteus nanus, Clavaria Kunzei*, some very fine specimens of *Clavaria corniculata, C. fistulosa* and *C. Ardenia, Boletus rugosus* and *Otidea cochleata*.

In the evening Mr A. W. Bartlett gave his paper on "A New Species of *Urophlyctis* causing galls on *Lotus corniculatus*," and Miss Cayley described some pure cultures of certain Mycetozoa.

On Friday the woods in the opposite direction were worked, namely, at Fairy Glen and Pandy Mills. Here the species found were very much the same as on previous days. Particularly noteworthy was the abundance of *Leotia lubrica*, both the common yellowish form and a larger one with greenish head and more scaly stalk. On heathy slopes numerous specimens of

Microglossum atropurpureum were found, and *Microglossum viride* was also recorded for this day. *Nolanea pascua* was also especially abundant.

In the evening Mr Rea commented on the finds of the week. The meeting was brought to a close with the usual votes of thanks to landowners, and to Mr Whitehead of Bangor for aid in making arrangements for the Foray.

For assistance in compiling the subjoined list of species collected the Secretary is indebted to all members present, and more particularly to Mr Rea, Mr Ramsbottom, Mr Pearson, Mr Buddin, Mr E. W. Mason.

List of Species gathered during the Foray.

B. = Round Bettws; *L.* = Llanrwst; *H.* = Hafod Woods; *S.* = Swallow Falls; *F.* = Fairy Glen.

HYMENOMYCETES.

Amanita porphyria (A. & S.) Fr., *H.*, mappa (Batsch) Fr., *L.*, *H.*, muscaria (Linn.) Fr., *L.*, *H.*, *S.*, rubescens (Pers.) Fr., *L.*, *H.*, *S.* and var. annulosulphurea Gillet, *F.*

Amanitopsis vaginata (Bull.) Roze, *B.*, *L.*, fulva (Schaeff.) W. G. Sm., *H.*, *S.*, *F.*

Lepiota rhacodes (Vitt.) Fr., *L.*, granulosa (Batsch) Fr., *B.*, *L.*, *S.*, amianthina (Scop.) Fr., *B.*, *L.*, *H.*, *S.*, *F.*, seminuda (Lasch) Fr., *H.*

Armillaria mellea (Vahl) Fr., *B.*, *H.*, *S.*, *F.*

Tricholoma resplendens Fr., *L.*, *H.*, albobrunneum (Pers.) Fr., *L.*, *H.*, rutilans (Schaeff.) Fr., *L.*, *S.*, terreum (Schaeff.) Fr., *B.*, *L.*, *H.*, argyraceum (Bull.) Fr., *B.*, cuneifolium Fr., *F.*, saponaceum Fr., *B.*, *H.*, sulphureum (Bull.) Fr., *S.*, bufonium (Pers.) Fr., *S.*, album (Schaeff.) Fr., *B.*, *L.*, *H.*, *S.*, militare (Lasch) Fr., *H.*, melaleucum (Pers.) Fr., *L.*, phaeopodium (Bull.) Quél., *L.*

Russula delica Fr., *S.*, nigricans (Bull.) Fr., *H.*, *S.*, *F.*, adusta (Pers.) Fr., *L.*, *H.*, azurea Bres., *S.*, cyanoxantha (Schaeff.) Fr., *L.*, *H.*, *S.*, citrina Gillet, *S.*, furcata (Pers.) Fr., *S.*, consobrina Fr. var. sororia (Larb.) Fr., *S.*, ochroleuca (Pers.) Fr., *L.*, *H.*, *F.*, fellea Fr., *L.*, *H.*, *S.*, drimeia Cke., *B.*, fragilis (Pers.) Fr., *L.*, *H.*, *S.* and var. fallax (Schaeff.) Massee, *S.*, emetica (Schaeff.) Fr., *L.*, *S.*, atropurpurea (Krombh.) Maire, *S.*, graminicolor (Secr.) Quél., *F.*, vesca Fr., *S.*, lutea (Huds.) Fr., *S.*

Mycena pura (Pers.) Fr., *L.*, *H.*, Adonis (Bull.) Fr., *B.*, *S.*, flavo-alba Fr., *B.*, *F.*, rugosa Fr., *S.*, galericulata (Scop.) Fr., *H.*, *S.*, polygramma (Bull.) Fr., *L.*, *H.*, *S.*, *F.*, inclinata Fr., *F.*, ammoniaca Fr., *L.*, *F.*, filopes (Bull.) Fr., *H.*, Iris Berk., *S.*, vitilis Fr., *S.*, speirea Fr., *S.*, haematopus (Pers.) Fr., *H.*, sanguinolenta (A. & S.) Fr., *H.*, *S.*, galopus (Pers.) Fr., *L.*, *H.*, *S.* and var. alba Fl. Dan., *H.* and var. nigra Fl. Dan., *L.*, *H.*, epipterygia (Scop.) Fr., *L.*, *H.*, *S.*, *F.*, vulgaris (Pers.) Fr., *H.*, *S.*, rorida Fr., *L.*, *H.*

Collybia platyphylla (Pers.) Fr., *H.*, *S.*, maculata (A. & S.) Fr., *H.*, distorta Fr., *H.*, tuberosa (Bull.) Fr., *L.*, atrata Fr., *H.*

Marasmius peronatus (Bolt.) Fr., *L.*, *H.*, erythropus (Pers.) Fr., *H.*, hariolorum (DC.) Quél., *H.*, dryophilus (Bull.) Karst., *L.*, *H.*, *F.* and var. aquosus (Bull.) Rea, *H.*, *S.*, ramealis (Bull.) Fr., *L.*, *H.*

Androsaceus rotula (Scop.) Pat., *S.*, androsaceus (Linn.) Pat., *L.*, *H.*, *S.*, instititius (Fr.) Rea, *H.*

Lactarius torminosus (Schaeff.) Fr., *S.*, turpis (Weinm.) Fr., *H.*, *S.*, pubescens Fr., *L.*, *S.*, blennius Fr., *L.*, *H.*, *S.*, *F.*, pyrogalus (Bull.) Fr., *H.*, chrysorheus Fr., *H.*, piperatus (Scop.) Fr., *H.*, *S.*, vellereus Fr., *S.*, deliciosus (Linn.) Fr., *B.*, *S.*, quietus Fr., *H.*, *F.*, aurantiacus (Fl. Dan.) Fr., *H.*, *F.*, vietus Fr., *L.*, *H.*, *S.*, glyciosmus Fr., *L.*, *H.*, *S.*, *F.*, volemus Fr., *L.*, *S.*, *F.*, serifluus (DC.) Fr., *L.*, *H.*, *S.*, *F.*, mitissimus Fr., *S.*, subdulcis (Pers.) Fr., *L.*, *H.*, *S.*

Hygrophorus hypothejus Fr., *B.*, pratensis (Pers.) Fr., *B.*, *L.*, *H.*, *S.*, *F.*, virgineus (Wulf.) Fr., *B.*, *F.*, niveus (Scop.) Fr., *H.*, *S.*, metapodius Fr., *B.*, subradiatus (Schum.) Fr., var. lacmus Fr., *F.*, irrigatus (Pers.) Fr., *L.*, *F.*, laetus (Pers.) Fr., *L.*, *H.*, *F.*, ceraceus (Wulf.) Fr., *L.*, *F.* coccineus (Schaeff.) Fr., *L.*, *H.*, *S.*, *F.*, miniatus Fr., *H.*, puniceus Fr., *B.*, *H.*, *S.*, *F.*, conicus (Scop.) Fr., *H.*, *S.*, chlorophanus Fr., *H.*, *S.*, psittacinus (Schaeff.) Fr., *H.*, *F.*, nitratus (Pers.) Fr., *L.*

Clitocybe nebularis (Batsch) Fr., *L.*, *H.*, clavipes (Pers.) Fr., *S.*, infundibuliformis (Schaeff.) Fr., *H.*, *S.*, catinus Fr., *S.*, ditopus Fr., *S.*, inversa (Scop.) Fr., *H.*

Laccaria laccata (Scop.) B. & Br., *L.*, *H.*, *S.*, *F.* and var. amethystina (Vaill.) B. & Br., *L.*, *H.*, *S.*, *F.*

Omphalia umbellifera (Linn.) Fr., *H.*, fibula (Bull.) Fr., *H.*, gracilis Quél., *B.*

Pleurotus geogenius (DC.) Fr., *B.*, *L.*, *S.*, *F.* (on sawdust), acerosus Fr., *F.*

Cantharellus cibarius Fr., *B.*, *L.*, *H.*, *S.*, *F.*, tubaeformis Fr., *H.*, *S.*, infundibuliformis (Scop.) Fr., *H.*, *S.*, lutescens (Pers.) Fr., *L.*, *H.*, *S.*

Nyctalis parasitica (Bull.) Fr., *L.*

Lentinus cochleatus (Pers.) Fr., *L.*, *S.*, *F.*

Panus stipticus (Bull.) Fr., *L.*, *H.*, *S.*, *F.*

Lenzites betulina (Linn.) Fr., *B.*, flaccida (Bull.) Fr., ? *S.*

Pluteus cervinus (Schaeff.) Fr., *F.*, eximius Saund. & Sm. (on sawdust), *B.*, *F.*, nanus (Pers.) Fr., *S.* and var. lutescens Fr., *H.*

Entoloma sericeum (Bull.) Fr., *H.*, nidorosum Fr., *L.*, *H.*, *F.*

Nolanea pascua (Pers.) Fr., *H.*, *S.*, *F.*, papillata Bres., *L.*, *H.*

Leptonia chalybaea (Pers.) Fr., *H.*, *S.*

Paxillus involutus (Batsch) Fr., *H.*, *S.*, *F.*, panuoides Fr., *B.*, *L.*, *S.*, *F.*, atrotomentosus (Batsch) Fr., *S.* (on sawdust).

Pholiota squarrosa (Müll.) Fr., *L.*, *S.*, marginata (Batsch) Fr., *S.*, mutabilis (Schaeff.) Fr., *L.*

Inocybe pyriodora (Pers.) Fr., *S.*, rimosa (Bull.) Fr., *H.*, *S.*, geophylla (Sow.) Fr., *S.*, *F.*, Godeyi Gillet, *S.*, hystrix Fr., *S.*, cincinnata Fr., *H.*, *S.*, *F.*, fastigiata (Schaeff.) Fr., *F.*

Astrosporina asterospora (Quél.) Rea, *F.*, petiginosa (Fr.) Rea, *H.*, *S.*, proximella (Karst.) Rea, *H.*

Hebeloma mesophaeum Fr., *S.*, crustuliniforme (Bull.) Fr., var. minus Cke., *S.*, fastibile Fr., *H.*

Naucoria melinoides Fr., *L.*, *H.*, *F.*, escharoides Fr., *H.*, *F.*

Galera tenera (Schaeff.) Fr., *S.*, *F.*, hypnorum (Schrank) Fr., *L.*, *H.*, *F.*, mycenopsis Fr., *L.*

Tubaria furfuracea (Pers.) W. G. Sm., *L.*, *H.*, *S.*, *F.*

Flammula sapinea Fr., *B.*, *L.*, *S.*, *F.*, ochrochlora Fr., *S.*

Cortinarius (Phlegmacium) varius (Schaeff.) Fr., *L.*, *S.*, largus Fr., *S.*, cyanopus (Secr.) Fr., *F.*

C. (Myxacium) elatior Fr., *L.*, *H.*, *S.*, *F.*, delibutus Fr., *H.*

C. (Inoloma) alboviolaceus (Pers.) Fr., *B.*, *H.*, bolaris (Pers.) Fr., *L.*, *H.*, pholideus Fr., *H.*

C. (Dermocybe) tabularis (Bull.) Fr., *H.*, caninus Fr., *H.*, anomalus Fr., *H.*, *S.*, *F.*, lepidopus Cke., *H.*, spilomeus Fr., *H.*, phoeniceus (Bull.) Maire, *B.*, *S.*, semisanguineus (Brig.) Maire, *S.*, cinnabarinus Fr., *H.*, *S.*, cinnamomeus (Linn.) Fr., *L.*, *H.*, croceoconus Fr., *L.*

C. (Telamonia) torvus Fr., *L.*, *H.*, *S.*, impennis Fr., *H.*, hinnuleus (Sow.) Fr. *H.*, *S.*, brunneus (Pers.) Fr., *F.*, incisus (Pers.) Fr., *H.*, hemitrichus Fr., *H.*, *F.*, rigidus (Scop.) Fr., *H.*, *S.*, paleaceus (Weinm.) Fr., *H.*, *S.*, *F.*

C. (Hydrocybe) subferrugineus (Batsch) Fr., *F.*, saturninus Fr., *F.*, castaneus (Bull.) Fr., *H.*, *S.*, erythrinus Fr., *H.*, *F.*, decipiens (Pers.) Fr., *L.*, *H.*, *S.*, *F.*, germanus Fr., *F.*, obtusus Fr., *H.*, acutus (Pers.) Fr., *H.*, *S.*

Crepidotus mollis (Schaeff.) Fr., *H.*, *S.*, *F.*

Stropharia aeruginosa (Curt.) Fr., *L.*, *H.*, *S.*, albocyanea (Desm.) Fr., *L.*, *S.*, semiglobata (Batsch) Fr., *B.*

Anellaria separata (Linn.) Karst., *F.*

Hypholoma sublateritium (Schaeff.) Fr., *L.*, *H.*, *F.*, capnoides Fr., *S.*, *F.*,

epixanthum Fr., *L.*, *S.*, fasciculare (Huds.) Fr., *B.*, *H.*, *S.*, *F.*, dispersum Fr., *B.*, *S.*, lacrymabundum Fr. non Quél. *B.*, velutinum (Pers.) Fr., *S.*, appendiculatum (Bull.) Fr., *L.*, *H.*, *F.*, catarium Fr., *B.*, *L.*, *S.*, *F.*, hydrophilum (Bull.) Fr., *H.*, *S.*, *F.*, radicosum Lange (=Flammula inopus Auctt.), *S.*

Panaeolus campanulatus (Linn.) Fr., *L.*, *H.*, *F.*

Psathyra fibrillosa (Pers.) Fr., *H.*, *F.*

Psilocybe sarcocephala Fr., *S.*, uda (Pers.) Fr., var. Polytrichi Fr., *H.*, *S.*, bullacea (Bull.) Fr., *B.*, *H.*, semilanceata Fr., *L.*

Coprinus atramentarius (Bull.) Fr., *L.*, *F.*, lagopus Fr., F., plicatilis (Curt.) Fr., *F.*

Psathyrella atomata Fr., *S.*

Boletus elegans (Schum.) Fr., *L.*, *H.*, *S.*, piperatus (Bull.) Fr., *H.*, chrysenteron (Bull.) Fr., *L.*, *S.*, subtomentosus (L.) Fr., *B.*, pruinatus Fr., *H.*, edulis (Bull.) Fr., *S.*, calopus Fr., *B.*, versipellis Fr., *S.*, scaber (Bull.) Fr., *L.*, *H.*, *S.*, *F.*, rugosus Fr., *S.*, *F.*

Gyroporus cyanescens (Bull.) Rea, *F.*

Phaeoporus porphyrosporus (Fr.) Bat., *H.*

Fistulina hepatica (Huds.) Fr., *H.*

Polyporus perennis (Linn.) Fr., *L.*, *H.*, intybaceus Fr., *S.*, sulphureus (Bull., Fr., *L.*, giganteus (Pers.) Fr., *L.*, betulinus (Bull.) Fr., *L.*, *H.*, *S.*, *F.*, cuticularis (Bull.) Fr., *S.*, radiatus (Sow.) Fr., *H.*, amorphus Fr., *L.*, *F.*, adustus (Willd.) Fr., *F.*, caesius (Schrad.) Fr., *S.*, stypticus (Pers.) Fr., *L.*

Ptychogaster albus Cda, *L.*

Fomes annosus Fr., *L.*, *B.*

Polystictus versicolor (Linn.) Fr., *L.*, *H.*, *S.*, *F.*, abietinus (Dicks.) Fr., *H.*, *F.*

Poria sanguinolenta (A. & S.) Fr., *H.*, hymenocystis B. & Br., *S.*

Daedalea quercina (Linn.) Fr., *H.*

Phlebia merismoides Fr., *L.*, *S.*, radiata Fr., *S.*

Hydnum repandum (Linn.) Fr., *L.*, *H.* and var. rufescens (Pers.) Fr., *B.*, *S.*, *F.*, nigrum Fr., *S.*, ferrugineum Fr., *S.*

Irpex obliquus (Schrad.) Fr., *H.*, *S.*, *F.*

Acia uda (Fr.) Bourd. & Galz., *F.*

Odontia farinacea (Pers.) Quél., *H.*, bicolor (A. & S.) Bres., *F.*

Craterellus cornucopioides (Linn.) Fr., *L.*, *H.*, *S.*, crispus (Sow.) Fr., *L.*, *H.*, *S.*

Thelephora anthocephala (Bull.) Fr., *S.*, terrestris (Ehrh.) Fr., *S.*

Hypochnus fuscus (Pers.) Fr., *L.*, *H.*, umbrinus (Fr.) Burt, *H.*, fumosus Fr., *H.*

Stereum spadiceum Fr., *L.*, *H.*, *S.*, *F.*, rugosum (Pers.) Fr., *L.*, *H.*, *S.*, *F.*, hirsutum (Willd.) Fr., *L.*, *H.*, *S.*, *F.*

Hymenochaete rubiginosa (Dicks.) Lév., *H.*

Corticium caeruleum (Schrad.) Fr., *H.*, laeve (Pers.) Fr., *F.*, arachnoideum Berk., *H.*, atrovirens Fr., *S.*, Sambuci (Pers.) Fr., *H.*, *S.*, botryosum Bres., *L.*, confine Bourd. & Galz., *H.*, *F.*, comedens (Nees) Fr., *H.*, *S.*, praetermissum (Karst.) Bres., *H.*, *S.*

Peniophora pallidula Bres., *F.*, byssoidea (Pers.) von Hoehn. & Litsch., *L.*, sanguinea (Fr.) Bres., *L.*, velutina (DC.) Cooke, *L.*, setigera (Fr.) Bres., *L.*, *H.*, quercina (Pers.) Cooke, *H.*, *S.*

Cyphella muscigena (Pers.) Fr., *H.*

Solenia anomala (Pers.) Fr., *F.*

Clavaria cristata (Holmsk.) Fr., *L.*, *H.*, cinerea (Bull.) Fr., *L.*, *H.*, *S.*, *F.*, rugosa (Bull.) Fr., *S.*, Kunzei Fr., *S.*, corniculata (Schaeff.) Fr., *L.*, *S.*, umbrinella Sacc., *H.*, fusiformis (Sow.) Fr., *B.*, *H.*, luteo-alba Rea, *L.*, inaequalis (Müller) Fr., *H.*, *S.*, *F.*, vermicularis Fr., *H.*, fumosa (Pers.) Fr., *B.*, fistulosa (Holmsk.) Fr., *S.*, Ardenia (Sow.) Fr., *S.*

Pistillaria quisquiliaris Fr., *H.*, *S.*, *F.*

Hirneola auricula-Judae (Linn.) Berk., *S.*

Tremella mesenterica (Retz.) Fr., *H.*, *B.*, frondosa Fr., *H.*, *F.*, lutescens Pers., *L.*, *B.*, *H.*, *F.*

Exidia Thuretiana (Lév.) Fr., *H.*, *F.*, glandulosa (Bull.) Fr., *H.*, *S.*

Tremellodon gelatinosum (Scop.) Pers., *L.*, *H.*, *S.*

Dacryomyces deliquescens (Bull.) Duby, *L.*, *H.*, *S.*, *F.*

Calocera viscosa (Pers.) Fr., *L.*, *H.*, *S.*, *F.*, cornea (Batsch) Fr., *S.*, *F.*, stricta Fr., *L.*

GASTEROMYCETES.

Cynophallus caninus (Huds.) Fr., *H.*
Phallus impudicus (Linn.) Pers., *L.*, *H.*, *S.*
Lycoperdon saccatum (Vahl) Fr., *S.*, perlatum Pers., *L.*, *H.*, *F.*, pyriforme (Schaeff.) Pers., *L.*, *H.*, *S.*, *F.*
Crucibulum vulgare Tul., *F.*
Cyathus striatus (Huds.) Pers., *H.*
Scleroderma aurantium Pers., *L.*, *F.*, Geaster Fr., *H.*, *F.*, verrucosum (Vaill.) Pers., *H.*, *S.*
Sphaerobolus stellatus (Tode) Pers., *L.*, *F.*

UREDINEAE.

Uromyces Poae Rabenh., *S.*
Puccinia Violae (Schum.) DC., *S.*, Circaeae Pers., *S.*, Umbilici Guep., *F.*, Angelicae (Schum.) Fuck., *S.*, Centaureae Mart., *S.*, Hieracii (Schum.) Mart., *H.*, Chondrillae Corda, *S.*, variabilis Grev., annularis (Str.) Schlecht., *L.*, Menthae Pers., *S.*, obscura Schroet., oblongata (Link) Wint., graminis Pers. *on Oats*, *S.*, *F.*, Poarum Neils., *S.*
Gymnosporangium Juniperi Link, *S.*
Triphragmium Ulmariae (Schum.) Link, *S.*, *F.*
Phragmidium Fragariae (DC.) Wint., *S.*, violaceum (Schultz) Wint., *S.*, *F.*, Rubi (Pers.) Wint., *H.*
Coleosporium Tussilaginis (Pers.) Kleb., *S.*, *F.*, Melampyri Karst.
Pucciniastrum Epilobii (Pers.) Otth., *S.*
Thecopsora Vacciniorum (Link) Karst., *H.*, *S.*
Hyalopsora Polypodii (Pers.) Magn., *H.*
Melampsora Hypericorum (DC.) Schroet., *S.*
Melampsoridium betulinum (Pers.) Kleb., *H.*, *S.*, *F.*
Milesina Blechni Syd., *S.*

USTILAGINEAE.

Ustilago Hordei Jensen, *F.*
Entyloma microsporum Schroet., on *Ranunculus repens*, *F.*

PYRENOMYCETES.

Erysiphe Cichoracearum DC., on *Centaurea nigra*, *F.*, graminis DC., *S.*
Microsphaera Alni (DC.) Wint.
Podosphaera oxyacanthae (DC.) de By., on *Vaccinium Myrtillus*, *H.*
Phyllactinia Corylea (DC.) Karst.
Nectria cinnabarina (Tode) Fr., *F.*
Cordyceps militaris (Linn.) Link, *S.*, *F.*, ophioglossoides (Ehrh.) Link, *H.*, *F.*, capitata (Holmsk.) Link, *H.*, Forquignonii Quél., *H.*
Claviceps microcephala (Wallr.) Wint., *S.*
Chaetosphaeria phaeostroma (Dur. & Mont.) Fuck., *L.*
Stigmatea Robertiani Fr., *H.*, *F.*
Mycosphaerella maculiformis (Pers.) Schroet., *F.*, Rumicis (Desm.), *F.*
Diaporthe leiphaemia (Fr.) Sacc., *H.*, rostellata (Fr.) Nits., *F.*
Eutypa lata (Pers.) Tul., *H.*
Valsa ceratophora Tul., *F.*
Cryptospora corylina (Tul.) Fuck., *H.*
Melanconis stilbostoma (Fr.) Tul., *H.*
Diatrypella quercina (Pers.) Nits., *H.*, verrucaeformis (Ehrh.) Nits., *H.*
Diatrype disciformis (Hoffm.) Fr., *H.*
Hypoxylon fuscum (Pers.) Fr., *L.*, coccineum Bull., *L.*
Xylaria Hypoxylon (Linn.) Grev., *L.*, *H.*, *S.*, *F.*, carpophila (Pers.) Fr., *H.*, polymorpha (Pers.) Grev., *F.*
Phyllachora graminis (Pers.) Fuck., *F.*

HYSTERIALES.

Dichaena quercina Fr., *H.*
Rhopographus Pteridis (Sow.) Wint., *H.*, *S.*

TUBERALES.

Elaphomyces granulatus Fr., *H.*, *F.*

MYRIANGIALES.

Myriangium Duriaei Mont. & Berk., *H.*

DISCOMYCETES.

Helvella crispa (Scop.) Fr., *H.*, lacunosa Afz., *S.*
Leptopodia elastica (Bull.) Boud., *H.*, *F.*, *S.*
Macropodia macropus (Pers.) Fuck., *H.*
Galactinia badia (Pers.) Boud., *L.*, saniosa (Schrad.) Sacc., *H.*
Otidea onotica (Pers.) Fuck., *H.*, *S.*, *F.*, cochleata (Linn.) Fuck., *S.*
Peziza aurantia Pers., *S.*, *F.*, luteo-nitens, B. & Br., *F.*, *L.*
Lachnea hemisphaerica (Wigg.) Gill., *S.*
Ciliaria scutellata (Linn.) Quél., *H.*, *S.*, *F.*, trechispora (B. & Br.) Boud., *L.*
Cheilymenia coprinaria (Cooke) Boud., *S.*
Ramsbottomia lamprosporoides Buckley, *S.*
Ascobolus denudatus Fr. (on sawdust), *F.*
Trichoglossum hirsutum (Pers.) Boud., *B.*
Microglossum atropurpureum (Batsch) Karst., *S.*, *F.*, viride (Pers.) Gill., *F.*
Leotia lubrica (Scop.) Pers., *L.*, *H.*, *S.*, *F.*
Cudoniella acicularis (Bull.) Schroet., *L.*, *H* , *S.*
Pachydisca Laburni (B. & Br.) Boud., on Birch, *H.*
Calycella citrina (Hedw.) Quél., *H.*, *S.*, *F.*
Coryne sarcoides (Jacq.) Tul., *L.*, *H.*, *S.*, *F.*
Bulgaria inquinans (Pers.) Fr., *L.*, *H.*, *S.*, *F.*
Orbilia xanthostigma Fr., *H.*, *S.*, *F.*
Hyalinia inflatula (Karst.) Boud., *H.*
Sclerotinia Curreyana (Berk.) Karst., *S.*, *F.*
Phialea firma (Pers.) Gill., *L.*, *H.*, *S.*, *F.*
Chlorosplenium aeruginosum (Oeder.) de Not., *H.*, *S.*, *F.*
Helotium fructigenum (Bull.) Fuck., *L.*, *H.*, *S.*, *F.*, virgultorum (Wahl.) Karst., *H.*, herbarum (Pers.) Fr., *F.*, epiphyllum (Pers.) Fr., *H.*
Dasycypha virginea (Batsch) Fuck., *H.*, *S.*
Trichopeziza caesia (Pers.) Boud., *H.*, *F.*
Mollisia cinerea (Batsch) Karst., *H.*, *S.*, *F.*
Phacidium multivalve (DC.) Kunze, *H.*
Pezicula eucrita Karst., *H.*
Stegia Ilicis Fr., *H.*
Coccomyces coronatus (Schum.) de Not., *S.*
Rhytisma acerinum (Pers.) Fr., *L.*, *H.*, *S.*, *F.*

PHYCOMYCETES.

Spinellus fusiger (Link) van Tiegh., *H.*

SPHAEROPSIDALES.

Phoma samararum Desm., *S.*
Macrophoma Fraxini Delacr., *H.*
Septoria Violae Westd., *H.*

HYPHOMYCETES.

Aegerita candida Pers., *F.*
Oidium alphitoides Griff. & Maubl., *S.*, *F.*
Ovularia obliqua (Cooke) Oud., *H.*, *S.*, *F.*
Botrytis cinerea Pers., *S.*
Trichoderma viride (Pers.) Fr., *H.*, *F.*
Ramularia acris Lindr., *H.*, *F.*, lactea (Desm.) Sacc., *S.*, Taraxaci Karst., *S.*, variabilis Fuck., *S.*
Sepedonium chrysospermum (Bull.) Fr., *S.*
Bispora monilioides Corda, *S.*
Cercospora Mercurialis Pass., *F.*
Stilbella erythrocephala (Ditm.) Lind., *H.*
Tilachlidium tomentosum (Schrad.) Lind., *H.*, *S.*, *F.*
Isaria farinosa Fr., *H.*

MYCETOZOA FOUND DURING THE BETTWS-Y-COED FORAY.

September 23rd to 26th, 1924.

By G. Lister.

Our four days' search in the neighbourhood of Bettws-y-Coed yielded a number of exceptionally interesting Mycetozoa. Notwithstanding the heavy rainfall of the preceding days, and much rain falling also on September 24th, thirty-seven species were obtained, nine of which and one variety appear to be new records for Wales. The most prolific hunting-grounds were afforded by large heaps of old sawdust, formed chiefly from coniferous wood. On them were found *Fuligo septica*, *Lycogala epidendrum*, *Hemitrichia Vesparium* and three species of *Cribraria*. *Cribraria argillacea* was developing from dark lead-coloured plasmodium; *C. vulgaris* var. *aurantiaca* from yellow plasmodium which changed to green as the sporangia began to form, and *C. piriformis* from pale slate-coloured plasmodium*: this, on being brought indoors, continued to creep on the surface of the sawdust for nearly a fortnight, throwing up irregular lobes and columns before forming sporangia, which were at first greyish-white, then dark brown and finally, on drying, pinkish brown.

On wet mossy rocks abundance of the bright yellow plasmodium and brown sporangia of *Badhamia rubiginosa* var. *globosa* were found, together with *Lamproderma columbinum* var. *brevipes*, both species being in their usual habitat; *Hemitrichia leiotricha* was also obtained on wet moss. On exposed rock and dead leaves were found several masses of the confluent form of *Stemonitis fusca* var. *trechispora*; the capillitium and columellae are imperfectly developed, and the spores, which measure 8 μ, are marked with bands forming a wide reticulation. The sharply reticulated spores of this variety are often associated with imperfectly developed capillitium; it has also been observed that after the clustered sporangia have been exposed to rain while maturing, they not infrequently assume a confluent form: it is possible, therefore, that the previous wet weather may account in some measure for the present irregular development. Three species of *Didymium* and *Comatricha lurida* were obtained from a thick bed of decaying holly leaves. *Cienkowskia reticulata* was found on a fallen oak bough, maturing from orange plasmodium; part of it, on being brought indoors, continued to creep about in a moist chamber for ten days longer, and then

* The colour of the plasmodium of *C. piriformis* was first observed by Mr N. G. Hadden, near Porlock, Somerset, in July, 1924.

developed into a group of both simple and branched plasmodiocarps; the walls are marked with characteristic shining crimson patches, which when still moist appeared as prominent convex pink warts; they consist of some waxy substance as they stain deep crimson on being treated with alkannin. Similar waxy deposits occur on the sporangium walls of *Trichia Botrytis* var. *cerifera* and in the stalks of *Diachea cerifera*. *Cienkowskia reticulata*, though widely distributed, has been recorded only three times previously in the British Isles, namely, from Cornwall, Leicestershire and Aberdeenshire. Two other rare species obtained on the Foray were *Diderma lucidum* and *Amaurochaete cribrosa*. Of the former species four sporangia were found on decayed wood near Bettws-y-Coed, only a few miles from Trefriw, the locality where it was first discovered in 1860; *Diderma lucidum* has since been seen repeatedly in wooded glens in Merionethshire; apart from these Welsh gatherings, it has been recorded only from Ceylon. Two aethalia of *Amaurochaete cribrosa* were found on fir bark. This is the fourth record of the species in Britain; although widely distributed it appears to be nowhere common. It is distinguished from the more abundant *A. fuliginosa* (Sow.) Rost. by having smaller aethalia, and more regular capillitium which forms a loose elastic network of slender arching threads. A piece of decayed wood, overgrown partly with moss, partly with gelatinous algae, was brought back from near the Swallow Falls, and kept moist, as it seemed a likely habitat for *Colloderma oculatum*, and on it, two months later, November 24th, two sporangia of this species made their appearance.

In the following list of our gatherings the species marked with an asterisk are new records for Wales:

Badhamia rubiginosa (Chev.) Rost.
Physarum nutans Pers. and the var. leucophaeum Lister.
Fuligo septica (L.) Gmel.
F. muscorum Alb. & Schw.
*Cienkowskia reticulata (Alb. & Schw.) Rost.
Leocarpus fragilis (Dicks.) Rost.
Diderma deplanatum Fries.
D. lucidum Berk. & Broome
Didymium nigripes Fries.
D. melanospermum (Pers.) Macbr. var. minus Lister.
D. squamulosum (Alb. & Schw.) Fries.
*Colloderma oculatum (Lippert) Lister.
*Stemonites fusca Roth and var. trechispora-confluens Lister.
Comatricha nigra (Pers.) Schröter.
C. laxa Rost.
*C. lurida Lister.
Lamproderma columbinum (Pers.) Rost. var. brevipes G. Lister.
*L. echinulatum Rost.
*Amaurochaete cribrosa (Fries) Sturgis.
Cribraria argillacea Pers.

C. vulgaris Schrad. var. aurantiaca Lister.
*C. piriformis Schrad.
Reticularia Lycoperdon Bull.
Lycogala epidendrum (L.) Fries.
Trichia persimilis Karsten.
T. varia Pers.
T. decipiens (Pers.) Macbr.
T. Botrytis Pers.
*T. floriformis (Schwein.) G. Lister.
Hemitrichia Vesparium (Batsch) Macbr.
*H. leiotricha Lister.
*H. abietina (Wigand) Lister.
Arcyria ferruginea Sauter.
A. cinerea (Bull.) Pers.
A. pomiformis (Leers) Rost.
A. denudata (L.) Wettstein.
A. incarnata Pers.

MYCETOZOA FROM MATLOCK.

By W. T. Elliott.

The following is a list of Mycetozoa collected at the Matlock Spring Foray, 1924:

Ceratiomyxa fruticulosa Macbr.
Physarum nutans Pers.
P. compressum A. & S.
Didymium squamulosum Fr.
Comatricha nigra Schr.
C. typhoides Rost.
Leocarpus fragilis Rost.
Reticularia Lycoperdon Bull.
Lycogala epidendrum Fr.
Trichia varia Pers.
Trichia persimilis Karst.
T. Botrytis Pers.
T. decipiens Macbr.
T. contorta Rost.
Hemitrichia Vesparium Macbr.
Arcyria cinerea Pers.
A. incarnata Pers.
Perichaena corticalis Rost.
P. depressa Lib.

BETTWS-Y-COED LICHENS.

By H. H. Knight, M.A.

The River Conway on which Bettws-y-Coed is situated divides the two counties of Carnarvon and Denbigh. The greater number of the Lichens on this list are from the former county, but on the second day of the Foray we crossed the Conway, and collected some Lichens on the Denbigh side of the river. The more important of these have the letter *D* after the name. With the exception of *Cladonia uncialis* and *Umbilicaria*, which were brought in from a distance, all the Lichens on this list were found within two miles of our headquarters. Several calcareous Lichens were noticed; these came from mortared walls. In one place on the main road to Capel Curig *Gyalecta cupularis* was plentiful on the shaded side of the wall, both on mortar and rock.

The following Lichens were found fertile: *Parmelia physodes, P. fuliginosa, Pertusaria globulifera, Phlyctis argena.* I am indebted to Mr Paulson for help in compiling this list.

Sphaerophorus melanocarpus Schaer.
S. globosus Wain.
Placynthium nigrum S. F. Gray
Collema pulposum Ach.
C. cheileum Ach.
C. granuliferum Nyl.
Leptogium turgidum Cromb.
L. lacerum S. F. Gray
Parmeliella corallinoides A. Zahlbr.
P. plumbea Wain.
Pannaria rubiginosa Del. var. conoplea Koerb.
Massalongia carnosa Koerb.
Peltigera canina Willd.
P. rufescens Hoffm.
and var. praetextata Nyl.
P. scutata Koerb.
P. polydactyla Hoffm.
P. horizontalis Hoffm.
Nephronium lusitanicum Nyl.
Sticta fuliginosa Ach.
S. limbata Ach.
Lobaria scrobiculata DC.
L. laciniata Wain.
L. pulmonaria Hoffm.
Parmelia physodes Ach.
P. pertusa Schaer.
P. perlata Ach.
and var. ciliata Schaer.
P. saxatilis Ach.
and forms furfuracea and panniformis
P. sulcata Tayl.
P. dubia Tayl.
P. hyperopta Ach.
P. laevigata Ach.
P. revoluta Floerke
P. conspersa Ach.
and var. stenophylla Ach.
P. omphalodes Ach.
P. Delisei Nyl., *D.*
P. fuliginosa Nyl.
and var. laetevirens Nyl.
Cetraria glauca Ach.
and var. fallax Ach
C. aculeata Fr.
Evernia prunastri Ach.
Ramalina farinacea Ach.
Usnea florida Web.
and var. hirta Web.
U. plicata Web.
Placodium citrinum Anzi
P. ferrugineum Hepp. var. festivum A. L. Sm.
P. rupestre Branth. & Rostr.
Candelariella vitellina Müll.-Arn.
Physcia grisea A. Zahlbr.
Physcia stellaris Nyl. var. aipolia Nyl.
P. orbicularis Nyl. var. virella Dalla Torre & Sarnth.
Rinodina demissa Arn.
Lecanora muralis Schaer
L. subfusca Ach. var. chlarona Ach. and var. allophana Ach.
L. campestris B. de Lesd.
L. coilocarpa Ach.
L. atra Ach.
L. conferta Nyl.
L. galactina Ach.
L. varia Ach.
L. symmicta Ach.
L. piniperda Koerb.
L. sulphurea Ach.
L. polytropa Schaer.
L. intricata Ach.
L. badia Ach.
L. tartarea Ach.
L. subtartarea Nyl.
L. parella Ach.
L. gibbosa Nyl.
L. lacustris Th. Fr.
L. Dicksonii Nyl.
Acarospora fuscata Th. Fr.
Haematomma ventosum Massal., *D.*
Pertusaria globulifera Nyl.
P. faginea Leight.
P. lactea Nyl.
P. pertusa Dalla Torre & Sarnth.
P. dealbata Cromb.
and f. corallina Cromb.
P. leioplaca Schaer.
P. Wulfenii DC.
Thelotrema lepadinum Ach.
Phlyctis argena Koerb.
Diploschistes scruposus Norm.
Crocynia lanuginosa Hue
Umbilicaria pustulata Hoffm.
Baeomyces rufus DC.
Stereocaulon pileatum Ach., *D.*
S. coralloides Fr.
S. paschale Fr., *D.*
Cladonia sylvatica Hoffm.
C. uncialis Web.
C. pyxidata Hoffm.
C. fimbriata Fr.
and var. simplex Wain.
C. cervicornis Schaer.
C. gracilis Willd.
C. furcata Schrad.
C. squamosa Hoffm.
C. caespiticia Floerke
C. digitata Hoffm.
C. flabelliformis Wain.
C. macilenta Hoffm.

Cladonia Floerkeana Fr. var. carcata Wain
Coenogonium ebeneum A. L. Sm.
Gyalecta cupularis Schaer.
Lecidea Friesii Ach.
L. confertula Stirt., *D.*
L. lucida, Ach.
L. quernea Ach.
L. coarctata Nyl.
L. fuliginea Ach.
L. protrusa Fr.
L. parasema Ach.
L. contigua Fr.
L. sorediza Nyl.
L. crustulata Koerb.
L. confluens Ach.
L. lapicida Ach.
L. lithophila Ach.
L. plana Nyl.
L. lactea Floerke
L. fuscoatra Ach.
L. rivulosa Ach.
Biatorella pruinosa Mudd
Biatorina lutea Arn.
B. atropurpurea Massal.
B. lenticularis Koerb.
Bilimbia sabulosa Massal.
B. sabuletorum Branth & Rostr.
Bacidia arceutina Branth. & Rostr. var. hypnaea A. L. Sm.
B. umbrina Branth. & Rostr.
Buellia myriocarpa Mudd
B. impressula A. L. Sm.
B. disciformis Mudd
B. parmeliarum Oliv. on Parmelia saxatilis
Leciographa parasitica Mudd on Pertusaria Wulfenii
Rhizocarpon Oederi Koerb.
R. geographicum DC.
R. viridiatrum Koerb.
R. petraeum Massal. and var. excentricum A. L. Sm.
R. confervoides DC.
Arthonia radiata Ach.
Opegrapha atra Pers.
O. betulina Sm.
O. vulgata Ach.
O. zonata Koerb.
Graphis elegans Ach.
Graphina anguina Müll.-Arg.
Dermatocarpon miniatum Th. Fr.
Normandina pulchella Cromb.
Verrucaria submersa Schaer.
V. nigrescens Pers.
Acrocordia biformis Arn.
Arthopyrenia punctiformis Arn.
A. pyrenastrella Oliv., *D.*
A. cinereopruinosa Koerb., *D.*
A. analepta Massal., *D.*
Porina chlorotica Wain.
Pyrenula nitida Ach.

STUDIES IN ENTOMOGENOUS FUNGI.

(With 1 Text-fig.)

VIII. NOTES ON BEAUVERIA.

By T. Petch, B.A., B.Sc.

In 1835, Balsamo-Crivelli described, under the name *Botrytis Bassiana*, a fungus which was parasitic on the silkworm, the larva of *Bombyx mori*, in Italy, where it caused a disease known as Calcino, because of the chalky appearance of the insects attacked. A paper dealing with this disease was published by Vittadini in 1851; and subsequently the fungus was studied by de Bary, who gave a full account of its morphology and mode of parasitism in his paper, "Zur Kenntnis insektentödtender Pilze," in 1867. In France, the disease of silkworms caused by this fungus is known as Muscardine, from the supposed resemblance of the affected insect to a sugared almond.

In 1891, Delacroix described a similar species, which occurred on a cockchafer, as *Botrytis tenella* and, with Brongniart, another species on the migratory locust of Algeria, as *Botrytis Acridiorum*.

Brongniart, however, had previously published an account of the fungi parasitic on the migratory locust, in which he referred to the latter species as *Botrytis* with round spores, and to another species as *Botrytis* with oval spores; and in including these two in the *Sylloge Fungorum*, x (1892), Saccardo had named the first of them *Botrytis Delacroixii* and the second *Botrytis Brongniartii*. Saccardo's name, *Botrytis Delacroixii*, stands, as the name *Botrytis Acridiorum* had previously been applied to another fungus by Trabut.

Shortly after the publication of the name *Botrytis tenella*, Giard showed that this fungus had been described by Link as *Sporotrichum densum* in 1809. Giard adopted the name *Isaria densa* (Link) Fr., as the fungus may produce coremia.

In *Fungi Italici* (1881), Saccardo had figured a *Botrytis tenella* Sacc. This was described as a subspecies of *Botrytis Bassiana* in *Sylloge Fungorum*, IV, p. 119 (1886). It had globose spores, and is evidently quite different from *Botrytis tenella* Delacr. But Saccardo did not figure the typical conidial heads of the *Botrytis Bassiana* group, nor did he mention them in his description. His illustration shows quite a different type of conidiophore. Hence it is doubtful whether this species is allied to *Botrytis Bassiana*.

Meanwhile, in South America, Spegazzini had described another member of this group in 1880 as *Sporotrichum globuliferum*. This had been found on the coleoptera, *Monocrepidium* sp. and *Naupactus xanthographus*, in the Argentine; and it was subsequently recorded from the same country on *Gargaphia* (*Hemiptera*). In the same paper, Spegazzini described *Sporotrichum minutulum* on larvae of *Fidicina bonaerensis* (*Cicadae*), and in 1881 or 1882, *Sporotrichum minimum* on *Atta lundii* Guer. (*Formicae*), from the Argentine, but from the descriptions it would appear that these two are not similar to *Botrytis Bassiana*.

The name *Sporotrichum globuliferum* Speg. has usually been employed in America for fungi of this group, *e.g.* for the fungus of the chinch bug (*Blyssus leucopterus*).

In 1895, Pettit published an account of cultures he had made of several species of entomogenous fungi. Among these were *Sporotrichum densum*, of which a pure culture had been obtained from Paris, where the fungus was then being sold for destroying cockchafer grubs; *Sporotrichum globuliferum* Speg., found on a Carabid beetle in the United States; *Sporotrichum globuliferum* Speg., on the chinch bug from Kansas; *Sporotrichum globuliferum* Speg., on *Vespa* sp. from the United States; *Sporotrichum minimum* Speg., on a black ant, *Camponotus*, from Ithaca; and a new species, *Isaria vexans*, on *Lachnosterna* (*Coleoptera*), from Ithaca Pettit placed the last species in

Isaria because it formed coremia, following Giard. It would seem doubtful whether his *Sporotrichum minimum* was identical with Spegazzini's.

Another species was added to this group in 1911, when Beauverie described *Botrytis effusa*, the red muscardine, on the silkworm. Silkworms attacked by this fungus acquire a red tint at one stage of the disease, but it was styled the red muscardine, chiefly because, when cultivated on potato, it colours the potato red. Morphologically it resembles *Botrytis Bassiana*, differing in forming a dense floccose growth in culture.

In the following year, Saccardo described *Botrytis Melolonthae*, found on *Melolontha vulgaris* in Italy. It was said to differ from *Botrytis tenella* in having oval spores. Evidently *Botrytis tenella* Sacc. was meant. The description of the spores agrees with those of *Botrytis tenella* Delacroix, *i.e. Sporotrichum densum* Link; but, as in the case of *Botrytis tenella* Sacc., it is not evident from the description that *Botrytis Melolonthae* belongs to the group under consideration.

In 1923, Bally described *Botrytis Stephanoderis*, on *Stephanoderes hampei* in Java. He had compared the Javan species in culture with *Botrytis Bassiana* obtained from the Centraalbureau voor Schimmelcultures at Baarn, and decided that the two were different, though the differences were quantitative rather than qualitative. *Botrytis Stephanoderis* grew more luxuriantly in culture, formed larger heads of spores in which the spores remained longer attached, and produced coremia regularly on potato.

It will have been noted that European mycologists have followed Balsamo in referring species of this group to *Botrytis*, while American mycologists have agreed with Link that they should be included in *Sporotrichum*. But they do not fit well in either genus; and in 1912 Vuillemin instituted for them a new genus, *Beauveria*, in which he placed the species

Beauveria Bassiana (Bals.) Vuill. = *Botrytis Bassiana* Bals.
Beauveria densa (Link) Vuill. = *Sporotrichum densum* Link
= *Botrytis tenella* Delacr.
Beauveria effusa (Beauv.) Vuill. = *Botrytis effusa* Beauv.

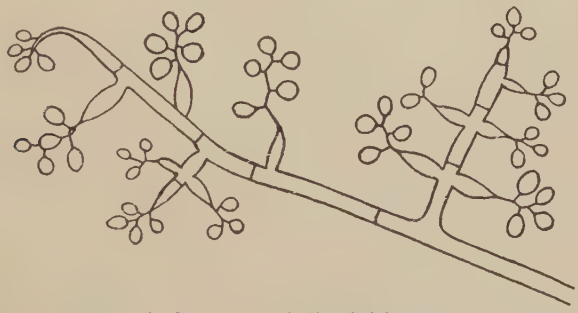
Picard, who published a paper on entomogenous fungi in 1914, transferred Spegazzini's species to the new genus as

Beauveria globulifera (Speg.) Pic. = *Sporotrichum globuliferum* Speg.

Morphology.

The species of *Beauveria* which are found on insects have hyaline hyphae, white or pale yellow in mass, or in some cases and on some media pinkish or reddish in part. In culture, the mycelium is at first loose, and floccose or tufted. Some forms, on the development of conidia, sink into a continuous pulveru-

lent layer; others remain floccose, or after the first formation of conidia and the production of a uniform stratum of spores resume their mycelial growth and fill the tube with woolly masses of hyphae. This secondary growth occurs to some extent in all the strains or species which I have had in cultivation. In those which, as a whole, cease growth after the production of the pulverulent layer of conidia, it takes the form of scattered tufts of hyphae, or of definite compact coremia; in the others, as already stated, the secondary growth covers the original conidial surface with thick woolly mycelium, which fills the tube, sometimes producing loose, somewhat indefinite, coremia. This secondary growth is the more remarkable in that it occurs when the media are drying out.



Text-fig. 1. *Beauveria* from *Oecophylla*: initial stages of formation of conidial heads (branches in excess of two at a whorl omitted). × 1000.

The conidia are borne in loose, globose heads, either on the main hyphae or on short lateral branches. In the latter case, the branch terminates in an elongated, flask-shaped or subcylindric phialide (basidium). Below this, two or more lateral branches more or less at right angles to the primary branch are produced in a whorl; these also terminate in phialides, and may bear branches in the same manner as the primary branch. This process is repeated several times, but it is impossible to determine the limits of the repetition. At any stage, phialides may be produced instead of lateral branches.

Each phialide bears a slender sterigma at the apex, or sometimes two. Bally has figured two in some instances in *Botrytis Stephanoderis*, and I have noted two in *Sporotrichum globuliferum*. After the formation of the first conidium, the sterigma gives off a branch a little distance below it on which another conidium is produced, and this process is repeated until a cyme of conidia is formed, the conidia being arranged alternately on short pedicels on a slender axis. The axis or sterigma is only about 0·5 μ in diameter, and is usually zig-zag or flexuose. This

slender cymose sterigma is the distinguishing character of the genus *Beauveria*.

In general, the conidia do not readily fall off. In *Botrytis Bassiana* they fall off apparently more easily than in other species, and it is possible in that species to find sterigmata from which all but the terminal two or three conidia have disappeared (de Bary; Bally). But in the tropical forms, the conidia usually remain attached for a long time. Immediately on examining one of these fungi it is observed that the head does not break up when mounted, nor do the phialides separate if it is subjected to pressure. Treatment which would resolve the head of, say, a *Sterigmatocystis* into fragments has little effect on the head of a *Beauveria*. The phialides, the long sterigmata, and the persistent conidia form a complex in which it is impossible to trace the arrangement of the separate parts.

De Bary showed that when the conidia are germinated in a thin film of water, the germ tubes, after they have attained a length of six to ten times the diameter of the spore, produce conidia of a different shape and in a different manner. The apex of the hypha becomes attenuated and abstricts a single conidium, or a small head consisting of a few conidia is formed. These conidia differ from the normal conidia, in the first place, in that they lack separate pedicels; they are free on the apex of the sterigma and disperse readily. In the second place, they are not globose, but oblong-cylindric, about the same diameter as, or slightly narrower than, the globose conidia, and three to four times as long. De Bary named these conidia, cylinder conidia. He added that cylinder conidia were produced in the foregoing manner at the apex of germ tubes which remained entirely submerged in water; and also that if the conidia were germinated in a sugar solution or weak gelatine, the germ tubes branched in the culture medium and produced cylinder conidia, both at the apices of the hyphae and on short sterigmata at the apices of the lateral branches. After the formation of cylinder conidia, the hyphae continued their growth and produced normal heads of globose conidia.

The formation of cylinder conidia was observed by Pettit. With regard to *Beauveria densa*, Pettit stated that elongate spores were thrown off in the agar from the ends of short branches, in contrast to the production of conidia on flask-shaped basidia (phialides) on the aerial mycelium. In the case of *B. globulifera*, he wrote: "In three days cylindrical conidia are thrown off in the agar from the terminations of slender threads. After about four days after sowing, conidia are borne outside the agar. The sterigmata [*i.e.* phialides] are terminal or sessile on the ends of short branches. The sterigmata are tipped

with small spherical conidia." Pettit did not describe the typical, slender, cymose sterigma of *Beauveria*, though there are indications of it in his figures (*e.g.* No. 84, and the unnumbered figure to the left of that).

Recently, Dufrenoy has called attention to the same phenomenon in *Beauveria globulifera*, and has added further details concerning the variation in the mode of production of the conidia. He states that the hyphae at first may bud off large, oval conidia, or may produce small conidia apically on cylindrical phialides. Subsequently swollen phialides are produced, with the typical, thread-like, *Beauveria* sterigma, and these may become forked, yielding several sterigmata, or may be grouped in pairs on the vegetative hyphae, or may be grouped into a head at the apex of a differentiated phialidiferous hypha.

Classification.

The morphological differences between the alleged species of *Beauveria* which are parasitic on insects are very slight, according to the published descriptions. Practically the only tangible difference is that, apart from the cylinder conidia, some have globose conidia and others have oval conidia. That, however, is not absolute. The species with globose conidia have the majority of their conidia globose, but a large percentage broadly oval; while those with oval conidia have some conidia globose. A Ceylon species which has the majority of its conidia globose, 1·2–1·75 μ diameter, has some conidia broadly oval, 1·5–2 × 1·2–1·5 μ; and another, in which the majority are oval, 2–3·5 × 1·5–2 μ, has a few globose, 1·5 μ diameter. The shape and size of the conidia do not vary on the different culture media which have been tried.

Beauveria Bassiana, according to de Bary, has globose conidia, 2·5–2·8 μ diameter. Delacroix gives 2–2·5 μ. But Sawada (*Descriptive Catalogue of the Formosan Fungi*) figures them as globose or broadly oval; and in a culture of this species from the National Collection of Type Cultures, they are broadly oval, 1·5–2·5 × 1·2–2 μ or globose, 1·5 μ diameter.

On the spore character, the recorded species may be classified as follows:

Conidia globose: *Beauveria Bassiana* (Bals.) Vuill.; conidia 2·5–2·8μ (de Bary); 2–2·5μ (Delacr.).
B. Delacroixii (Sacc.); conidia 2–2·5μ (Delacr.).
B. globulifera (Speg.) Picard; 2–2·5 × 1·5–2μ (Speg.); 1·75–2·5μ (Pettit).
B. vexans (Pettit); conidia nearly spherical (Pettit).
B. effusa (Beauv.) Vuill.; conidia as in *B. Bassiana* (Beauverie).
B. Stephanoderis (Bally); conidia 2–3μ (Bally).

Conidia oval: *B. densa* (Link) Vuill.; conidia 2·5–3 × 1·5–2μ (Delacr.).
B. Brongniartii (Sacc.); conidia 4 × 2·5μ (Sacc.).

As already noted, there is a marked difference in the habit of these fungi in nature or in culture; and this difference has been utilised in the separation of species. Some species cover the insect with an even, finely pulverulent layer which has a chalky appearance, *e.g. B. Bassiana*. Others cover the insect with a loose cottony or woolly mycelium. This difference may be reproduced in culture; Picard states that cultures of *B. densa* are distinguished from *B. Bassiana* by being cottony, not chalky.

In cultures, this difference is well marked on the production of conidia. Growth on the agar, etc. is of course hyphal or tomentose at first. When the conidia are formed, the heads may be produced in such numbers that they cover the whole of the surface of the culture with a continuous stratum which entirely hides the hyphae except at the margin. In *B. Bassiana*, the heads are small, and consequently the surface appears chalky, *i.e.* finely pulverulent, like the surface of a newly-broken piece of chalk. But in the allied tropical species, the conidial heads are larger, and the surface is mealy or coarsely pulverulent.

In cultures of some species, the conidia occur in scattered masses united by fine strands of hyphae. A similar appearance results when the conidial heads are produced on a rather loose weft of mycelium. This appearance will be designated cottony.

Other species produce in culture dense floccose masses resembling cotton wool, or thick locks of true wool. As a rule these species produce conidia only on part of the culture; or if the whole slant bears conidia, it is subsequently overgrown by dense floccose masses. This type of culture will be designated woolly.

The presence or absence of coremia is not a constant character. De Bary and Delacroix both obtained coremia in *Beauveria Bassiana*. But Bally did not observe them in that species, and makes their absence one of the distinguishing characters between *B. Bassiana* and *B. Stephanoderis*.

In the absence of any well-marked morphological characters, the practice has been adopted of differentiating between species biologically, *i.e.* by the colours produced in culture on certain media, viz. on potato and on gelatine. This again is not altogether satisfactory. Picard notes that the colour is not constant with repeated subcultures, and states that this is an advantage, as the disappearance of the power of imparting a colour to the medium coincides with a loss of virulence of the fungus as a parasite on insects. It is, however, a decided disadvantage, if species are to be identified by the colours they produce.

Picard gives the following key to four of the European species:

Mycelium mealy or chalky	... ...	... ...	*B. Bassiana*
Mycelium floccose or cottony	Spores oval	Potato coloured lie de vin, and gelatine red	*B. densa*
	Spores globose	Potato coloured red. Gelatine not coloured	*B. effusa*
		Neither potato nor gelatine coloured	*B. globulifera*

To the above may be added the following details, derived from the published accounts and descriptions:

B. Bassiana.	Does not colour potato: colours gelatine light chestnut (Delacroix).
B. effusa.	Differs from *B. Bassiana* only in its floccose mycelium and in producing a red colour on potato (Beauverie).
B. Delacroixii.	Does not colour potato: colours gelatine pale fugacious rose (Delacroix).
B. globulifera.	Colours potato purple, or slightly purple (Pettit).
B. vexans.	Colours potato distinctly purple; fructification exactly the same as in *B. globulifera* (Pettit). This is probably only a coremioid form of Pettit's *B. globulifera.*
B. Stephanoderis.	No colours recorded.
B. densa.	Colours gelatine and potato intense red (Delacroix); colours potato deep purple-red and gelatine deep vinaceous purple (Pettit).
B. Brongniartii.	Resembles *B. densa,* but does not colour gelatine red (Delacroix).

With regard to *Beauveria densa,* it may be noted that no two of the three observers cited are entirely in agreement, though Pettit worked with a culture of *B. densa* obtained from Paris.

Picard differs from Pettit as regards *Beauveria globulifera.* This species was introduced from North America into Algeria in 1892, and was distributed for the purpose of destroying *Haltica ampelophaga.* No appreciable result was observed in the following three years; but in 1896 a *Beauveria* was found on *Haltica* and this was considered to be the introduced American species. Subsequently it was introduced into France (from Algeria), without any immediate result. In 1911–12, however, an epidemic of *Beauveria* occurred on *Haltica ampelophaga* in the district into which the Algerian fungus had been introduced, and the species was again identified as *Sporotrichum globuliferum.* The accounts of French investigators relate to this re-discovered species, and, as will be evident from the results recorded in this paper, there is room for doubt whether the French *B. globulifera* is the same as Pettit's, and whether either of them is, biologically, *Sporotrichum globuliferum* Speg.

Material.

Specimens of *Beauveria* have been found in Ceylon on a Phalangid; on a Locustid, *Aularches miliaris*; on an undeter-

mined Curculionid; on a queen red ant, *Oecophylla smaragdina*; on the red coconut weevil, *Rhynchophorus ferrugineus*; on a Chrysomelid, *Metriona circumdata*; on a *Mantis*; and on an undetermined fly. In each case, only one example has been found. The first six agree in the shape and size of their conidia, which are globose, 1·5–2 μ diameter, or broadly oval, 1·5–2·5 × 1·2–2 μ. The seventh and eighth, on a *Mantis* and a fly respectively, have oval conidia, 2–3·5 × 1·5–2 μ, with a few globose, 1·5 μ diameter.

On all these insects, the heads of conidia occur chiefly in bands along the joints. The fungi on *Aularches* and *Rhynchophorus* are coarsely pulverulent, cream-coloured. Those on *Oecophylla*, *Metriona* and *Mantis* are cottony, loosely pulverulent, cream or pale buff; while that on a fly is similar but white. That on a Curculionid is woolly, coarsely pulverulent along the joints, but forming a continuous stroma on the under surface.

A specimen of *B. globulifera* on *Gargaphia*, kindly furnished by Dr Spegazzini, is cottony, forming a loose covering round the outer edge of the insect. This is an old specimen, no longer viable.

B. Bassiana has been recorded on silkworms, etc. in India, but I have not been able to obtain a specimen.

Specimens of *B. Stephanoderis* on *Stephanoderes hampei* were kindly forwarded by Dr K. Friederichs. These, however, had been baked to prevent any possible introduction of the insect, and consequently are not viable. The growth of the fungus is scanty, cream-coloured and cottony. The conidia are globose, 1·2–2·5 μ, or broadly oval, 2–2·5 × 1·5–2 μ. This species evidently belongs to the *B. Bassiana* group.

With the foregoing were sent untreated examples of a *Beauveria* on a Halticid on *Vigna oligosperma*, as the same species. The latter, however, though similar in appearance to *B. Stephanoderis*, has oval conidia, 2·5–4 × 1·5–2 μ, with some globose, 1·2–2·5 μ diameter. It belongs to the *B. densa* group.

Viable examples of *B. Stephanoderis* were subsequently obtained through the kindness of Dr H. Begemann.

The first six of the Ceylon forms agree in spore characters with *B. globulifera*, the spores of which were given originally as globose or globoso-elliptic, 2–2·5 × 1·5–2 μ. But those on *Aularches*, *Rhynchophorus*, and the Curculionid differ from the available specimens of that species in the character of the mycelium. The seventh and eighth Ceylon forms agree with *B. densa* in having oval spores, the dimensions of which are almost identical with those given by Delacroix for that species, viz. 2·5–3 × 1·5–2 μ.

Cultures.

Of the Ceylon forms on a Phalangid, a Locustid, and a Curculionid, only old herbarium specimens were available. The first had been preserved in formalin, while the second and third were seven years old and their conidia did not germinate. The specimen on *Oecophylla* was obtained in April, 1922, and was taken into culture on November 24th of the same year. That on *Rhynchophorus* was collected on October 22nd, 1922, and was taken into culture on the same date as the previous specimen. Both these had been kept in an air-tight box with calcium chloride. The specimen on *Mantis* was collected at the end of February, 1923, and was taken into culture on March 10th, 1923. That on *Metriona* was collected at the beginning of September, 1923, and was taken into culture on September 9th. The first comparisons of this series were made on parallel cultures during September—December, 1923; consequently the various forms had been in cultivation for different periods. They had been subcultured at intervals of about two months. With these were compared *B. Bassiana* and *B. densa*, kindly supplied by the National Collection of Type Cultures.

The specimen on a fly was collected in April, 1924, and was taken into culture on April 11th. That on a Halticid from Java was received in July, 1924, and was taken into culture on July 11th. Parallel cultures of these and the forms previously taken into cultivation were run on maize meal agar, gelatine, and Raulin neutral agar in July and November, 1924.

Viable specimens of *B. Stephanoderis* were received in 1925, and this species was taken into culture on February 2nd. Parallel cultures of all the forms were again run on maize meal agar, and of those longest in cultivation on all the other media.

Cultures were begun by plating out on maize meal agar. In general, and in all the later subcultures, transfers in successive subcultures of one strain were made to all the media from one of the maize meal agar tubes of the previous subculture. In the earlier stages of the work, transfers were made to each medium from the previous subculture on that medium, but this method was abandoned, probably prematurely, as the results appear to indicate. Stock cultures were maintained on maize-meal agar.

The following media were used, with agar, in tube cultures:

Naegeli's fluid, No. 3, with cane sugar; *p*H 6·2–5·9.

Raulin's fluid, original formula; *p*H about 3 (the indicators available did not permit a lower determination).

Neutral Raulin's fluid (Guéguen, *Bull. Soc. Myc. France*, XIV, p. 205); *p*H 6·2–6·1.

Dox's solution, with sodium nitrate and cane sugar; *p*H 7·1–6·5.

Maize-meal; *p*H 5·5 approx.

Cultures were also made on gelatine, 25 per cent., *p*H 5·2, and, in the earlier stages. on 10 per cent. gelatine; the latter was not solid at Peradeniya.

The two figures for the *p*H represent two determinations, one on the medium freshly made, the other after keeping for a month. These were kindly determined by Dr C. H. Gadd.

The tubes were kept with the surface of the slant horizontal, at the temperature of the laboratory (73°–83° F.).

Cultures were also made on potato slabs, sterilised, in Roux tubes.

In doubtful cases the colour of the agar was ascertained by removing the whole slant from the tube (after a brief immersion in hot water), cutting off the agar and placing it on white paper.

Final comparisons were usually made at the end of a month.

Maize-meal agar.

The fungus from *Oecophylla* formed an even, cream-coloured pulverulent layer. In the original culture, strands of white mycelium spread over the glass. White coremia up to 4 mm. high developed in some cultures. When old, the conidial layer was frequently interrupted by minute white tufts of mycelium. The agar was not reddened.

The fungus from *Rhynchophorus* was similar to the foregoing, but no coremia were produced. The agar was not reddened.

The fungus from *Metriona* gave a growth of the same character as the previous two, without coremia. The agar was not reddened.

Beauveria Stephanoderis formed an even pulverulent layer, slightly zoned, cream-coloured, inclined to yellow. The agar was reddened, especially towards the base of the slant. The culture differed from that of the fungus on *Oecophylla* in its colour, and in colouring the medium.

B. Bassiana, when first received, formed an even, white, chalky layer. No coremia were produced, and the agar was not reddened.

B. densa produced a growth indistinguishable from that of *B. Bassiana*, except slightly inclined to cottony at the upper edge. The agar was reddened.

The fungus from *Mantis* formed a dense, woolly growth, yellowish in colour. Loose club-shaped processes arose from the base of the slant and almost filled the tube. Conidia were at first produced in a continuous, pulverulent, yellow layer at the

apex of the slant. Subsequently they were produced anywhere on the mycelium, but not in continuous masses. Subcultures were made on maize-meal slants, a month old, and consequently partly dried out. In these the growth at first resembled that of the previous strains, a yellow, even, pulverulent layer of conidia being formed; but, subsequently, dense woolly masses of mycelium were produced, which covered the original growth and filled the tube. The agar was reddened.

The fungus from a fly gave a zoned, cream-coloured, pulverulent growth at first. Scattered tufts of mycelium subsequently developed, and these became pink, or salmon pink when in contact with the glass. The agar was reddened. In old cultures, the tufts became compact and pulvinate.

The fungus from a Halticid gave a thin, cottony growth, zoned at distant intervals with narrow bands of spore masses. The colour was distinctly lemon-yellow, and the agar was reddened. The growth of this fungus was less vigorous than that of any of the others. Coremia were produced at the top of the slant after three months.

Thus, on maize-meal agar, the growth of the *Oecophylla*, *Rhynchophorus* and *Metriona* strains was practically the same; the culture was pulverulent and cream-coloured, and the agar was not reddened. *B. Bassiana*, which belongs to the same group morphologically, gave a white, finely pulverulent or chalky growth, and did not redden the agar. But *B. Stephanoderis* differed from all the foregoing in reddening the agar.

The strain from *Mantis* gave a woolly growth, with yellow pulverulent spore masses. That from a fly gave a zoned, cream-coloured pulverulent growth, and that from a Halticid, a scanty, zoned, cottony, lemon-yellow growth. In *B. densa*, which is morphologically the same as these three, the culture was white, and finely pulverulent. All four agree in reddening the agar, but they differed markedly in the colour and appearance of the cultures. With reference to the zonation of certain cultures, it is to be noted that all were equally exposed to the light.

Naegeli agar.

The fungus from *Oecophylla* produced a thin, flat, cream or pale yellow, pulverulent layer. The reverse was pale yellow or pale buff, and the agar was not coloured.

The fungus from *Rhynchophorus* made a similar growth, but deep cream or deep buff. The reverse was buff, becoming orange-red. The agar was not coloured.

The *Metriona* fungus showed a more extensive growth than the previous two, but of the same character, and cream coloured. The reverse was pale yellow. The agar was not coloured.

Beauveria Stephanoderis gave a thin, cottony, pale cream layer, the reverse being orange-yellow. The agar was not coloured.

B. Bassiana gave a thin, white, pulverulent layer. The reverse was pale yellow, tending somewhat to orange-yellow. The agar was not coloured.

B. densa formed a thin, white, pulverulent layer, orange-red on the reverse. The agar was not coloured.

The growth of the *Mantis* fungus was similar to that of the first three, intermediate in extent between that of the first two and the third, and repeatedly zoned. The reverse at the end of a fortnight was orange-red with a yellow margin, but at the end of three weeks it had changed to a muddy olive-brown. The agar was coloured green or yellowish green.

The fungus from a fly gave a thin, cottony, pale cream growth, in diffuse patches, sometimes circular and zoned. The reverse was muddy red-brown in the centre, but elsewhere the growth was scarcely dense enough to show any colour. The agar was not coloured.

The Halticid strain formed a poor, flat, yellowish, cottony growth. The reverse was cream-coloured at first, becoming reddish, and finally changing to pale brown. The agar was not coloured.

All the strains grew poorly on this medium, a very thin, but usually opaque, stroma being produced. The *Mantis* strain was constantly, and the strain from a fly sometimes, zoned. Only the *Mantis* strain coloured the agar. On this medium, the *Rhynchophorus* strain differs from the *Oecophylla* and the *Metriona* strains in the colour of the reverse.

Raulin-neutral agar.

The fungus from *Oecophylla* formed a fairly thick, even, cream or pale yellow, pulverulent layer, with a rather broad, white, advancing margin. When old the culture became wrinkled. At the end of three weeks, deep yellow, terete, conical clavae appeared, arising from a deep yellow patch in the middle of the pulverulent spore layer. These clavae extended to the upper side of the tube, where they divided into strands spreading over the glass. The reverse of the culture was deep purple-red, fading subsequently to a muddy red with an orange margin in contact with the glass. The agar was not coloured.

The fungus from *Rhynchophorus* produced a similar growth, cream to pale yellow, but without clavae. The reverse was deep purple-red, fading to yellow with purple-red patches. The agar was coloured a deep purple-red or claret colour, this being the most intensely coloured culture of this series. The colour

ultimately became more concentrated in a transverse band at the level of the lower edge of the stroma.

The fungus from *Metriona* produced a dense, woolly mycelium, filling the lower part of the tube and covering the upper part of the slant with a loose fluffy white layer. At the end of a month, the upper part of the slant was a continuous, buff, pulverulent layer, while the lower part of the tube was stuffed with pale yellow, woolly mycelium, tinged pink here and there. The reverse was pale yellow to brownish yellow, becoming pale chestnut, and the agar was coloured yellow-brown.

Beauveria Stephanoderis produced a convoluted, deep cream, pulverulent layer, subsequently developing a white fluffy growth in the centre. The reverse was orange-yellow at first, becoming red-brown. The agar was not coloured. No coremia were produced.

B. Bassiana gave a white, even, pulverulent growth. The reverse was chestnut, and the agar ultimately became slightly yellow-brown.

B. densa gave a similar white pulverulent layer. The reverse was purple-red, and the agar was coloured purple-red, especially in a transverse band at the lower edge of the stroma.

The *Mantis* fungus produced at first a thick stroma, over about one-half the slant, pulverulent and buff in the centre, with a broad, cushiony, yellow, tomentose border. The stroma then developed a dense, woolly mycelium, pale yellow in colour, covering the masses of conidia and filling the lower part of the tube. Loose clavae were formed at the edge of the stroma. The reverse was purple-red, the agar becoming purple-red or claret-coloured.

The fungus from a fly gave an extensive compact stroma, convoluted in the centre, pulverulent, at first cream, becoming pinkish buff. Large woolly tufts developed subsequently in the centre and these were pinkish. The reverse was yellow at first, becoming yellow-brown to chestnut. The agar was coloured red-purple, especially in a band at the lower edge of the stroma.

The superficial growth of the Halticid strain was scanty. A fairly extensive mycelium developed within the agar, but the superficial growth was limited to small areas and was white and cottony. The submerged mycelium viewed from above was dull orange-yellow. The reverse was at first reddish yellow, becoming yellowish red to purple-red. The agar was coloured slightly purple-red, with a denser band at the lower edge of the stroma After two and a half months, the general surface growth was the same, but yellowish coremia were developing from various parts of the slant, with woolly masses here and there.

On this medium, the two European fungi retained their white

colour. The strains from *Oecophylla*, *Stephanoderes* and *Rhynchophorus* exhibited the same type of growth, but only the first produced clavae and only the last coloured the agar. The *Metriona* fungus departed from these two in its woolly growth and the coloration of the reverse and the agar. The *Mantis* fungus agreed with *B. densa* in its coloration of the agar, but differed in its woolly growth and the colour of the spore masses. That from a fly differed from all others in its pinkish buff spore masses, while the Halticid species differed in its habit of growth. The latter was so markedly different from that of this form on other media, and of all other strains, that contamination was suspected. The cultures, however, proved on examination to be *Beauveria*, and further cultures from stock on this medium gave the same type of growth.

Raulin agar.

This strongly acid medium did not become solid at Peradeniya. Growth occurred as floating islands of mycelium of various sizes, which ultimately coalesced into a more or less continuous stroma covering the surface of the liquid.

The fungus from *Oecophylla* formed a thick, continuous, irregularly wrinkled, cream-coloured, pulverulent stroma. The reverse was at first yellow, becoming purple-red with a yellow margin. The agar was not coloured.

The growth of the fungus from *Rhynchophorus* was similar, but the pulverulent spore masses were buff. The reverse was deep purple-red and the agar similarly coloured, the coloration being equal to that on Raulin-neutral agar.

The fungus from *Metriona* produced thick, fleecy masses of mycelium, which ultimately settled down into a more or less compact mass, covered with pale cream, pulverulent spore masses. The reverse at first varied from yellow to pinkish buff, and finally became yellow-brown to clay-coloured. The agar was tinged greenish yellow.

Beauveria Stephanoderis gave a good growth, pulverulent, cream-coloured, the reverse being yellow to orange-yellow. The agar was not coloured.

B. Bassiana gave a white chalky stroma. The reverse was orange-yellow in contact with the glass, yellow on the floating patches, the latter finally becoming isabelline in the centre. The agar was not coloured.

B. densa gave a white growth, pulverulent in the centre, but very woolly at the margin. The reverse was pale purple-red to blood-red, and the agar was not coloured.

The fungus from *Mantis* filled the tube with deep cream-coloured floccose masses of mycelium, salmon pink to carmine

at the edge of the slant. Conidia were produced in visible quantity only in a patch at the apex of the slant in deep cream-coloured masses. The reverse was reddish purple, and the agar was reddened.

The fungus from a fly gave a cream-coloured pulverulent stroma, with finally a slight woolly new growth. The reverse was pale purple-red at first, and finally red-brown. The agar was slightly coloured reddish brown.

The fungus on a Halticid produced floating pulvinate patches which coalesced slowly. After two and a half months the stroma was continuous, but thin, and the white spore masses did not hide the medium. The reverse was reddish yellow, and the agar was not coloured.

In general the characters on this medium ultimately resembled those on Raulin-neutral agar. The fungus on *Metriona* again gave a woolly mycelium, and differed from all the others in the colour of the reverse and of the agar. The growth of the Halticid fungus was again poor.

Dox agar.

The fungus from *Oecophylla* formed a thin, even, white, pulverulent layer. The reverse was flesh-coloured, and the agar was not coloured.

The fungus from *Rhynchophorus* gave a similar growth, cream to deep yellow. Subsequently, white tufts of mycelium developed and the culture became white, cottony, with deep yellow, pulverulent patches. The reverse was purple-red, and the agar was coloured slightly purple-red, the colour ultimately disappearing.

The fungus from *Metriona* produced a flat, but generally woolly, growth, pale yellow, varying finally from woolly to pulverulent. The reverse was yellow, becoming pinkish buff, and the agar was not coloured.

Beauveria Stephanoderis gave a thin, cottony, cream-coloured layer, the reverse being pale yellow. The agar was not coloured.

B. Bassiana formed a flat, compact, white, pulverulent layer. The reverse was pale orange and the agar was not coloured.

The growth of *B. densa* was similar to that of *B. Bassiana*. The reverse was brownish red, and the agar was slightly reddened.

The fungus from *Mantis* formed an even, flat, pulverulent layer, white, ultimately interrupted by yellow tufts. The reverse was deep reddish purple, and the agar reddish purple or claret-coloured.

The fungus from a fly covered the slant with a flat pulverulent stroma, at first cream, becoming pale yellow or greenish

yellow. The reverse was at first cream, then pale salmon, and then vivid carmine. At the end of a month the agar became reddish purple, with a concentration of colour at the base of the slant. After five weeks, the reverse of the upper part of the slant became yellow, and this change extended downwards slowly. New tufts of mycelium varied from white to pink.

The fungus on a Halticid gave a thin, cottony, white growth. The reverse was pale yellowish red, becoming purple-red, and the agar was slightly reddened. After two months, the cultures produced coremia at the sides of the slant, and woolly masses at the apex.

The most notable features of this series were the white spore masses in the cultures of the *Oecophylla* and *Mantis* strains, and the carmine reverse of the fly strain.

Gelatine.

Cultures were made on 10 per cent. and 25 per cent. gelatine. The former was semi-fluid at Peradeniya. In general, growth on the 25 per cent. was better than on 10 per cent. gelatine.

The fungus from *Oecophylla* produced a deep yellow woolly growth, but not extending far above the medium. The reverse was pale yellow to orange-yellow, and the gelatine was not coloured.

The fungus from *Rhynchophorus* formed a flat, pulverulent, cream-coloured layer. The colour of the reverse varied. In one series on 25 per cent. gelatine, it was pale ochraceous, with a faint reddish tinge in the lower part of the slant, while in another series it was yellow to orange-yellow, without any red tinge. On 10 per cent. gelatine, it was pale yellow to buff, with a small red patch at the point of inoculation. The gelatine was not coloured.

The fungus from *Metriona* produced a loose and cottony growth in the upper part of the slant, but a more woolly growth below. The reverse was pale yellow to orange-yellow, and the gelatine was not coloured.

Beauveria Stephanoderis formed a pale cream, cottony growth. The reverse was pale yellow at first, becoming pale purple-red in the centre. The gelatine was not coloured.

B. Bassiana gave a white, pulverulent layer in the first cultures, the reverse being yellow. The gelatine was not coloured. After three subcultures, the spore masses were cream.

B. densa gave a similar growth, the spore masses being somewhat scattered at the margin. The reverse was at first white, then became pale purple-red in the centre, and ultimately purple-black, all the mycelium in the medium also turning purple-black. The gelatine was not coloured.

The fungus from *Mantis* gave a flat, pulverulent, deep cream layer, inclining to woolly at the margin. The reverse was deep reddish purple, and the gelatine reddish purple (claret-coloured).

The fungus on a fly gave a pinkish buff pulverulent layer. The reverse was purple-red, and the gelatine was faintly coloured purple-red.

The Halticid strain gave a scanty, cottony, white growth. The reverse was yellowish red, and the gelatine was slightly reddened.

B. Bassiana, *B. Stephanoderis* and the allied strains from *Oecophylla*, *Rhynchophorus* and *Metriona* did not colour gelatine. *B. densa*, which, according to European investigators, should colour gelatine, failed to do so; it is possible that the available strain may have lost that property by repeated cultures. The *Mantis*, fly and Halticid strains, which are allied to *B. densa*, coloured gelatine, but the two last-named only slightly.

The fungus on *Oecophylla*, which gives a pulverulent growth on other media, became woolly on gelatine. It was not at first possible to distinguish *B. Bassiana* from *B. densa* by the appearance of the culture, except by the colour of the reverse, but after three subcultures, the spore masses of *B. Bassiana* became cream-coloured.

In all strains, the stroma tends to become funnel-shaped on gelatine, and if a red or purple colour is produced it usually appears first at the base of the funnel.

Potato.

Slabs of potato were sterilised in Roux tubes.

The *Oecophylla* and *Rhynchophorus* strains, within a week, formed a thin, even, cream-coloured covering of conidia over the whole surface. The potato was not coloured. The *Rhynchophorus* strain developed coremia at the end of a month, the stalks being deep yellow where they adhered to the glass.

Beauveria Stephanoderis produced a similar growth, somewhat thicker. The potato was not coloured.

The *Metriona* strain formed fluffy tufts of white mycelium with few conidia. After three weeks, the culture was still in this condition, but at the end of a month the upper part had collapsed into a loose cobwebby mass of mycelium and spores, while loose clavae, slightly pinkish in colour, arose from the base of the substratum, filling the lower part of the tube. The potato was not coloured.

B. Bassiana gave a flat, white, chalky growth, thicker than that of the *Oecophylla* and *Rhynchophorus* fungi. It was confined to the potato, which was not coloured.

B. densa gave a copious, white, woolly growth, partly filling

the tube. The coloration of the potato varied. In one series on Indian potato, a section of the slab showed a concave coloured zone, deep purple, becoming purple-red on exposure. Subsequently, owing to the difficulty of obtaining Indian potatoes free from *Bacillus Solanacearum*, Scotch potatoes were used, and the slabs of these were coloured uniformly purple throughout in the same time, the colour remaining unchanged on exposure.

The strain from *Mantis* enveloped the potato with a dense woolly growth which filled the lower part of the tube. This was white, with a pink tinge here and there. The potato was not coloured. No masses of conidia were evident at the end of a month.

The fungus from a fly gave a growth similar to that from *Mantis*, with a pink to salmon-pink tinge, more developed than in the latter. The potato was not coloured.

The Halticid strain gave an even, pulvinate, deep yellow growth over the potato, not extending to the wall of the tube. Except in colour, the growth resembled that of the *Oecophylla* strain. The potato was coloured pale reddish purple.

It is to be noted that the character of the growth in the several strains does not agree with their division into two groups on morphological characters. *B. Bassiana*, *B. Stephanoderis* and the *Oecophylla* and *Rhynchophorus* strains produce a flat growth, and *B. densa* and the *Mantis* and fly strains a woolly or cottony growth. But the *Metriona* strain, which belongs morphologically to the first group, produces a growth similar to those of the second group, while the Halticid strain, which belongs morphologically to the second group, produces a growth similar to those of the first group.

None of the *B. Bassiana* group colour potato. Of the *B. densa* group, two colour potato, but the other two do not, though they develop colour in the mycelium.

The Character of the Mycelium.

As the primary distinguishing character between the different species of *Beauveria*, the form of the mycelium has been employed, that of *B. Bassiana* being chalky, and that of *B. densa*, *B. effusa* and *B. globulifera* being cottony or floccose. Practically this difference is due to the relative quantities of conidia and hyphae produced. In some instances, the mycelium is relatively scanty and the conidia form a continuous powdery stratum which completely hides it; in others, the mycelium may be scanty or profuse, but in either case the conidial heads are relatively fewer and scattered. It has been claimed that this difference is maintained in culture, cultures of *B. Bassiana* being immediately distinguishable from those of *B. densa*.

The appearance in culture may vary with the age of the culture. The fungus from *Oecophylla*, when grown on gelatine, forms a pulverulent layer when the conidia are first formed, and then develops a woolly growth. Again, the fungus from *Mantis*, which has usually a woolly mycelium, forms at first a continuous pulverulent stratum, if grown on rather dry maize-meal agar, but develops a woolly mycelium later.

The appearance, in culture, at the end of a month, of the species or strains grown in the present investigation was, in the earlier stages of the work, as follows:

	Maize	Gelatine	Naegeli	Raulin neutral	Raulin	Dox	Potato
Oecophylla	mealy	woolly	mealy	mealy	mealy	mealy	mealy
Rhynchophorus	mealy	mealy	mealy	mealy	mealy	cottony	mealy
Metriona	mealy	woolly	mealy	woolly	mealy	woolly	cottony
Stephanoderis	mealy	cottony	cottony	mealy	mealy	cottony	mealy
Bassiana	mealy	mealy	mealy	mealy	mealy	mealy	mealy
densa	mealy	mealy	mealy	mealy	woolly	mealy	woolly
Mantis	woolly	mealy	mealy	woolly	woolly	mealy	woolly
Fly	mealy	mealy	cottony	mealy	mealy	mealy	woolly
Halticid	cottony	cottony	cottony	cottony	cottony	cottony	mealy

Only one of the nine, viz. *B. Bassiana*, retained the same growth character in all cultures. Contrary to the European accounts, it was not possible to distinguish *B. Bassiana* from *B. densa* by the type of growth on gelatine, though they differed on potato and on Raulin agar.

On Naegeli agar, on which growth was generally poor, all the strains were mealy or cottony; but on gelatine, on which growth was also poor, both the *Metriona* and the *Oecophylla* strains were woolly. This was the only medium, of those used, on which the *Oecophylla* strain was woolly. It will be evident that, in general, the type of growth of a given species of *Beauveria* is not constant, provided that a sufficiently extended range of media is employed.

On the character in question no two of nine strains could be regarded as the same.

The Coloration of the Medium.

The table on p. 264 gives the colour of the medium in the different cultures in the earlier stages of this investigation.

The fungus from *Oecophylla* was the only one which did not, at first, colour the medium in any culture, though *B. Bassiana* nearly approaches it in that respect, the colour imparted to Raulin-neutral agar by the latter being slight and tardily developed. *B. densa* did not colour gelatine in this series of cultures; this may have been due to the fact that it had been in culture for a long period, though, on the other hand, it coloured maize-meal, Raulin-neutral, Dox and potato. In

general, the species with oval spores, *e.g. B. densa* and the strain from *Mantis*, produce the strongest coloration, but the form from *Rhynchophorus* gives quite as deep a colour on Raulin-neutral.

TABLE.

	Maize	Gelatine	Naegeli	Raulin neutral	Raulin	Dox	Potato
Oecophylla	—	—	—	—	—	—	—
Rhynchophorus	—	—	—	purple-red	purple-red	slightly purple red	—
Metriona	—	—	—	yellow-brown	greenish yellow	—	—
Stephanoderis	reddened	—	—	—	—	—	—
Bassiana	—	—	—	slightly yellow-brown	—	—	—
densa	reddened	—	—	purple-red	—	slightly reddened	purple-red or purple
Mantis	reddened	reddish purple	green	purple-red	reddened	reddish purple	—
Fly	reddened	purple-red	red-brown	chest-nut	red-brown	reddish purple	—
Halticid	reddened	reddened	pale brown	purple-red	reddish yellow	purple-red	reddish purple

In this connection, the coloration of the reverse of the culture should also be considered. It is, indeed, questionable whether it is legitimate to distinguish in all cases between the coloration of the reverse of the culture and the general coloration of the medium. Lack of time has prevented an investigation of the mode of origin of the colouring matter, and its relation to the salts, etc. used in the culture media. But it would appear probable that the coloration of the reverse is due in some cases to the production of a colouring matter which remains in the stroma, while the coloration of the medium is due to an excess of the same colour which diffuses through the medium.

On Raulin-neutral agar, the strain from *Rhynchophorus* coloured the agar deep purple-red, that from *Mantis* coloured it a paler purple-red, while that from *Oecophylla* did not at first colour the agar. But in all three the reverse was purple-red, though differing in intensity. It might, therefore, be supposed that in the *Rhynchophorus* strain, an excess of pigment was produced which diffused into the medium; in the *Mantis* strain, less of the pigment, but still an excess which diffused; but in the *Oecophylla* strain, all the pigment was retained by the mycelium. The differences between these strains, as regards this character, would then be differences of degree.

That view, however, does not agree with all the recorded observations. In the case of the *Mantis* strain on Naegeli agar,

the colour which diffuses into the medium is not the same as that of the reverse. In the strain from a fly on Dox agar, the reverse was carmine, while the agar was coloured purple-red. But in the latter, at the end of a month, the colour began to concentrate at the bottom of the tube, leaving the reverse of the upper part of the slant pale yellow. On the other hand, when the reverse is reddish purple and the agar is not coloured, the reverse usually fades in course of time to a muddy flesh colour; the colour does not concentrate.

In *Beauveria densa* on gelatine, the reverse became pale purple-red in the centre and ultimately purple-black. The gelatine was not coloured, but the mycelium in it was purple-black. As *B. densa* is said to colour gelatine, there is consequently some doubt whether this effect would not be regarded as fulfilling that condition.

On potato, neither the *Mantis* nor the fly strain coloured the substratum. But both produced a pink coloration in the mycelium in contact with the potato.

The Impermanence of Cultural Characters.

In September, 1924, transfers were made from the stock cultures, which had been previously transferred in May. It was then noted that the growth of the *Oecophylla* strain was different, the mycelium being matted and compact, and bearing comparatively few conidia, and that the maize-meal agar was reddened. Parallel transfers of the *Rhynchophorus* and *Metriona* strains did not colour maize-meal agar. The *Oecophylla* and *Rhynchophorus* strains had then been in culture twenty-two months.

Transfers of the *Oecophylla* and *Rhynchophorus* strains at the end of December, 1924, gave the same result; and, in consequence, parallel cultures of the four original strains, viz. those on *Oecophylla*, *Rhynchophorus*, *Metriona* and *Mantis*, were made in January, 1925, from the stock cultures of May, 1924, on all the media except Raulin agar. It was then found that the reactions of these strains were not in all cases the same as when they were originally taken into culture.

On maize-meal agar, the *Oecophylla* strain formed a matted, compact layer, white to cream, with comparatively few conidia, and the agar was reddened. On Naegeli agar, the growth was poor, white and cottony, instead of cream-coloured and mealy, and the reverse became orange-red. On Raulin-neutral agar, the growth was cream-coloured and pulverulent, as before, and the reverse purple-red, but the agar was coloured, chiefly in a deep red purple zone towards the base of the slant. The growth on Dox agar and on gelatine was the same as before, and the fungus did not colour potato.

The *Rhynchophorus* strain still produced a deep cream-coloured mealy growth on maize-meal agar, but the agar was reddened, either generally or in patches. On Dox agar the reverse was yellowish red, instead of purple-red, and the agar was not coloured. On the other media, the characters were the same as in the initial cultures, except that the coloration of Raulin-neutral agar was not so intense as previously. This strain had been in culture for twenty-six months.

The *Metriona* strain gave a felted compact growth on maize-meal agar, similar to that of the *Oecophylla* strain, but it did not colour the agar. On Dox agar, the growth was still woolly, but after five weeks it was yellow only in the centre, and the reverse was orange-yellow, instead of pinkish buff. On other media the reactions were unchanged. This strain had been in culture for sixteen months.

The *Mantis* strain showed no change on maize-meal agar. On Raulin-neutral agar the coloration of the medium was less intense. On Naegeli agar, the reverse was red-brown, instead of olive-brown, and no green colour was obtained in the medium. This strain had been in culture for twenty-two months.

The salts used in the cultures were taken from the same stock throughout. The maize used in the later cultures was the yellow flint, commonly grown in Ceylon, whereas that used in the earlier cultures was a white dent. To ascertain whether the observed changes on maize-meal agar were due to the maize, cultures of all strains were run on maize-meal agar made from the white dent maize in February, 1925. The *Oecophylla* and *Rhynchophorus* strains again reddened the agar, though not so intensely as in the yellow maize-agar cultures.

Thus both the *Oecophylla* and *Metriona* strains showed a reduction in their capacity to produce conidia when grown on maize-meal agar, though they still produced a thick layer of conidia on other media. The other changes in the four strains were principally reductions in the intensity of the coloration of the agar, as has been previously recorded for species of *Beauveria* in Europe. But both the *Oecophylla* strain and the *Rhynchophorus* strain acquired the property of reddening maize-meal agar, and the former that of colouring Raulin-neutral agar.

Further, *Beauveria Bassiana*, which produced white chalky spore masses in culture when first received in December, 1923, gave a pale cream pulverulent growth in September, 1924, the conidial heads being larger than in the original culture. No change was observed in *B. densa*.

Consequently, the colour of the spore masses of a *Beauveria*, or the coloration produced by it in the medium, is not neces-

sarily constant on repeated subculture, and the change may take the form either of a reduction or loss of the original colour, or the acquisition of colour and the power of imparting colour to the medium.

The Parasitism of *Beauveria*.

If the type of growth in culture and the coloration of the different culture media are accepted as specific characters, then all the strains grown in the present series are different species. Hence it might be expected that each species of insect would have its own particular species of *Beauveria* parasitic upon it. Moreover, it is known that certain insects may be attacked by more than one species of *Beauveria*, *e.g.* the larva of *Bombyx mori*, by *B. Bassiana* and *B. effusa*. Consequently there opens up a prospect of an illimitable series of species of *Beauveria*.

On the other hand, it has hitherto been supposed that species of *Beauveria* are pleophagous. Spegazzini recorded *B. globulifera* as occurring on Coleoptera (*Monocrepidium* and *Naupactis xanthographus*) and on a *Gargaphia* (Hemiptera). Billings and Glenn state that the same species was found in North America on Coleoptera (*Trichobasis texana, Conotrachelus orinaceus, Anthonomus fulvus, Disonycha triangularis, Hippodamia convergens, Olibrus* sp.), on Hemiptera (*Blyssus leucopterus* and three other species), on Phymatidae (*Microtoma carbonaria, Coriscus ferus*, and another species), and on many common Pentatomids: while in France it has been recorded on *Haltica ampelophaga* (by Picard and others) and on caterpillars of *Cnethocampa pityocampa* (by Dufrenoy).

Beauveria Bassiana has been recorded on the larvae of *Bombyx mori*, on *Cochylis ambiguella* (by Fron), and on *Nonagria typhae* (by Portier and Sartory).

The foregoing records were, in general, not based on comparative cultures or on infection experiments. Giard, however, infected with *Beauveria densa* the larvae of *Tenebrio molitor, Anomala frischii* and *Polyphylla fullo* (Coleoptera); and caterpillars of *Acherontia atropos, Sphinx ligustri, Mamestra brassicae, Brotolomia meticulosa* and *Bombyx mori*. He failed to kill *Schistocerca peregrina*, several species of *Stenobothrus, Decticus verrucivorus* and *Locusta viridissima*. On these results *B. densa* can attack Coleoptera and Lepidoptera, but not Orthoptera.

Prillieux and Delacroix, using the same species of *Beauveria, B. densa*, successfully infected larvae of *Cetonia aurata* and *Rhizotrogus solstitialis*, and caterpillars of *Euproctis chrysorrhoea*.

Lecœur infected a Coleopteron, *Anthonomus pomorum*, and the chrysalis of a Lepidopteron, *Cheimatobia brumata*, from a culture of *Beauveria densa*.

Pettit did not succeed in infecting larvae of *Lachnosterna* (Coleoptera) with *Beauveria densa*. Working with *B. globulifera* from the chinch bug, he failed to infect *Aphis brassicae* and the larvae of a wireworm, *Agriotes mancus*, and only obtained one successful infection in four attempts on larvae of *Lachnosterna*. Using *Beauveria vexans* from *Lachnosterna*, he infected caterpillars of *Pieris rapae* and *Oedemasia concinna*, but failed with caterpillars of *Cycnia egle* and *Hyphantria cunea*: accidental infections from these cultures occurred on a red ant and on caterpillars of *Melitaea phaeton*.

Picard infected caterpillars of *Phthorimaea operculella* with *Beauveria globulifera*.

Conversely, Delacroix infected caterpillars of *Bombyx rubi* with *Beauveria Bassiana*, *B. densa* (from cockchafers), and *B. Delacroixii* (from a cricket).

Bally, after recording that *Beauveria Stephanoderis* occurred on other species of beetles in addition to *Stephanoderes hampei*, stated that caterpillars of *Cricula fenestrata* had been successfully infected with that fungus both in the laboratory and in the field.

Very many of the records of the host insects of the various species of *Beauveria* are open to question, as the fungi were not subjected to comparative culture. In one instance, it has been found that the fungi determined as the same species on two different insects are morphologically different. But where infection experiments have been attempted, these undoubtedly point to the pleophagy of these fungi, though one might urge as a possible objection the difficulty of obtaining for experiment insects which can be guaranteed sterile. It does not, however, appear probable from the recorded experiments that the parasitism of a given species of *Beauveria* is restricted to one species of insect, or even to one group of insects.

Consequently it is the more surprising that in the series of cultures recorded in this paper, three specimens of *Beauveria* with globose spores, collected by chance, should, if biological differences are considered specific, have proved to be three different species, and different from both *B. Bassiana* and *B. Stephanoderis*; and that the same should have occurred in the case of three specimens with oval spores, viz. those on a *Mantis*, a fly, and a Halticid, all of which, on the same consideration, differ from *B. densa*.

It has already been pointed out that, according to European investigators, the power of colouring the medium is not constant, but is lost by repeated subculturing, at least in *B. densa*. The same was observed in the present series in the case of the *Mantis* strain on Naegeli agar, while a diminution of colour

occurred in the case of the *Rhynchophorus* and the *Mantis* strains on Raulin-neutral agar. But, on the other hand, both the *Oecophylla* and the *Rhynchophorus* strains acquired the power of reddening maize-meal agar, and the former that of colouring Raulin-neutral agar.

It would appear, therefore, that the power of colouring the medium might depend upon the kind of medium on which the fungus had previously grown; and it would seem a legitimate suggestion that the same fungus, after having grown on different insects might produce different colorations of the media.

It is regretted that it has not been possible to obtain further examples of *Beauveria* on *Oecophylla*, etc. in order to determine whether the strains on these insects always produce the same colours in culture, nor to institute cross infection experiments and subsequent cultures with these fungi to determine whether the coloration of the medium varies if the same strain of *Beauveria* is taken into culture from different insects.

Infection experiments were attempted with *B. densa*, obtained from the National Collection of Type Cultures, on larvae of *Bombyx mori*, *Attacus ricini* and *Rhynchophorus ferrugineus*. Sprinkling the larvae with spores and keeping them in a damp chamber was unsuccessful. Direct inoculation by puncturing the larvae with a needle was also unsuccessful, the fungus developing neither on those which survived the operation, nor as a saprophyte on those which died in consequence of it.

Systematic.

The examples of *Beauveria* dealt with in this series of cultures, like the European forms, fall into two groups, viz. one group having conidia chiefly globose, and another having conidia chiefly oval. They thus correspond with *B. Bassiana* and *B. densa* respectively. They differ from those species in having larger conidial heads, which, with one exception, are cream-coloured to pale buff in mass in nature. This colour is, in general, maintained in culture; but the exception noted, viz. the strain on a fly, which is white in nature, gives deeper colours in culture than any other, while some forms which have cream-coloured spore masses in nature become white on certain media, viz. the *Oecophylla* and *Mantis* strains on Dox agar. Moreover, *B. Bassiana* from Europe, when grown on maize-meal agar in Ceylon, forms larger spore heads and becomes cream-coloured on repeated subculture. Consequently, both the size of the spore heads and the colour of the spore mass are variable characters.

From the recorded spore measurements, the forms with globose spores agree with *B. globulifera*, not with *B. Bassiana*. But an examination of European cultures of the latter shows

that this apparent difference is non-existent, the conidia of *B. Bassiana* varying from globose to broadly oval, and thus agreeing with those of *B. globulifera*.

B. Stephanoderis was described as a new species because it had larger conidial heads than *B. Bassiana*, and the conidia were cream in mass. But in the light of the present records, neither of these is a sufficient distinction. It differs from *B. Bassiana*, biologically, in reddening maize-meal agar and in the coloured reverse on gelatine.

The three Ceylon forms with globose spores agree with *B. globulifera* as described by European investigators in not colouring potato or gelatine Pettit, however, stated that *B. globulifera* coloured potato purple. But if the coloration of the medium is a specific character, these three Ceylon forms must be considered distinct from one another.

Of the strains with oval spores, all three colour gelatine to some extent, but only one, that on a Halticid, colours potato. Consequently, only the latter agrees with *B. densa* as recorded, though the strain of *B. densa* available for comparison coloured potato but not gelatine. But the Halticid strain differs from *B. densa* in the character of its growth on potato, while on the total of all the growth characters and colour reactions on different media, all four must be regarded as distinct species, if such characters are considered of specific value.

Cultures of *Beauveria* previously recorded have generally been confined to two media, viz. potato and gelatine, and consequently they do not afford sufficient data for comparison with the present series. Until further evidence is available, it would appear preferable to regard these Ceylon and Javan forms as possibly biologic forms of *B. Bassiana* and *B. densa* rather than to describe them as new species.

These results throw considerable doubt upon the value of the method of determining species of *Beauveria* by their behaviour in culture. They certainly indicate that, if that method is adopted, culture on two media only is inadequate.

Addendum.

Lycogala fragilis Holm (*Vid. Selsk. Skrifter, Nye Samling*, No. 1, Kbn. (1781), p. 288, fig. 5), on a dead cockchafer, was, from the figure and description, probably a *Beauveria*.

LITERATURE.

ARNAUD, G. Notes mycologiques (g. *Isaria* et *Parodiopsis*). Bull. Soc. Myc. France, XXXI, pp. 20–24. 1915. [Figs. of *Beauveria globulifera*.]

BALLY, W. *See* FRIEDERICHS, K.

BALSAMO-CRIVELLI, G. Osservazione sopra una nuova specie di Mucedinea del genere *Botrytis*, etc. Bibl. Ital. LXXIX, p. 125. 1835.

Balsamo-Crivelli, J. Aufstellung von zwei neuen Arten Mucedineen, *Botrytis Bassiana* und *Mucor radicans*, etc. Uebersetzt von V. Cesati. Linnaea, x, p. 609. 1835, 6.

—— Sopra l'origine e lo sviluppo della *Botrytis Bassiana*, etc. Bibl. Ital. xc, p. 367. 1838.

—— Ueber den Ursprung und die Entwicklung der *Botrytis Bassiana*, etc. Linnaea, xiii, p. 118. 1839.

Beauverie, J. Notes sur les Muscardines. Sur une Muscardine du Ver à Soie non produite par la *Botrytis Bassiana* Bals. Etude du *Botrytis effusa* n.sp. Rapport de la Commission administrative du Laboratoire d'Etudes de la Soie de Lyon, xiv, pp. 5–31. 1911.

—— Les Muscardines; genre *Beauveria*. Rev. Gen. Bot. xxvi, pp. 81–105, 157–173. 1914.

Billings, F. H. and Glenn, P. A. Results of the artificial use of the white-fungus disease in Kansas. U.S. Dept. of Agric., Bureau of Entomology, Bull. 107. 1911.

Brongniart, C. Le Cryptogame des Criquets pelerins. Compt. Rend. cxii, p. 1494. 1891.

—— and Delacroix, G. Les champignons parasites des acridiens. Compt. Rend. Soc. Philomat. Paris, No. 5. Dec. 26, 1891.

—— —— Les champignons parasites observes sur les criquets pelerins en Algerie. Soc. Nat. d'Agric. France. Oct. 1891.

de Bary, A. Zur Kenntniss insektentödtender Pilze. Bot. Zeitung, xxv, pp. 1, 9, 17, 1867; xxvii, pp. 585–593, 601–606. 1869.

Delacroix, G. Le Hanneton et sa larve; la moisissure parasite. Journ. d'Agric. pratique, p. 165. 30th Juillet, 1891.

—— Observations sur quelques formes *Botrytis* parasites des insectes. Bull. Soc. Myc. France, ix, pp. 177–184. 1893.

Dufrenoy, J. Metaphanic and progressive variation in *Beauveria*; its phyletic significance. Mycologia, xi, pp. 276, 277.

Fron, G. Note sur quelques Mucédinées observées sur *Cochylis ambiguella*. Bull. Soc. Myc. France, xxvii, pp. 482–487. 1911.

Friederichs, K. and Bally, W. Over de parasitische schimmels, die den koffiebessenboeboek dooden. Meded. v. h. Koffiebessenboeboek-fonds, No. 6. 1923.

Giard, A. *Isaria* parasite de la larve du Hanneton. Compt. Rend. Acad. Sci. 1 Juin, 1891.

—— Sur l'*Isaria densa* Link, parasite du ver blanc. Compt. Rend. Acad. Sci. 3 Août, 1891.

—— L'*Isaria densa* (Link) Fr. Champignon parasite du Hanneton commune. Bull. Sci. France et Belge. 5 Mai, 1893.

Jameson, A. P. Report on the diseases of silkworms in India. 1922.

Lecœur, E. Le *Botrytis tenella*, parasite de l'Anthonome et de la Chématobie. Bull. Soc. Myc. France, viii, pp. 20, 21. 1892.

Pettit, R. H. Studies in artificial cultures of entomogenous fungi. Bull. 97, Cornell Univ. Agr. Expt. Sta., Bot. and Ento. Division. July, 1895.

Picard, F. Les Champignons parasites des insects et leur utilisation agricole. Ann. Ecole Agric. Montpellier, xiii, pp. 121–248. 1914.

Prillieux, E. and Delacroix, G. Le parasite de la larve du Hanneton. Compt. Rend. Acad. Sci. 11 Mai, 1891; 20 Juillet, 1891. Soc. Nat. d'Agric. 24 Juin, 1891.

Portier, P. and Sartory, A. Sur une forme du *Botrytis Bassiana*, isolée de la chenille de *Nonagria typhae*. Compt. Rend. Soc. Biol. Paris, lxxix, pp. 769–773. 1916.

Sawada, K. Descriptive catalogue of the Formosan fungi. Agric. Expt. Sta., Govt. of Formosa, Special Bulletin, No. 19. 1919.

Spegazzini, C. [*Sporotrichum globuliferum*.] Fung.-Argent., Pug. ii, p. 42; Ann. Soc. Cient. Argentina, x, pp. 278–285.

Vittadini, C. Della natura del calcino o mal del segno. Giorn. Ist. Lomb. e Ital., 2 ser., iii, pp. 143–238, 1851; Mem. Ist. Lomb., Milano, iii, pp. 447–512. 1852.

Vuillemin, P. *Beauveria*, nouveau genre de Verticillacées. Bull. Soc. Bot. France, lix, pp. 34–40. 1912.

MUTINUS BAMBUSINUS (ZOLL.) ED. FISCHER.

(With Plates XIV–XVI.)

By T. Petch, B.A., B.Sc.

In May, 1912, a single specimen of a *Mutinus* was collected in the Royal Botanic Gardens, Peradeniya. Two years later, in October and November, 1914, the same species appeared in abundance in the decaying debris of an old clump of the Giant Bamboo (*Dendrocalamus giganteus*). From its general shape it was thought to be *Mutinus bambusinus* (Zollinger) Ed. Fischer, and it was recorded under that name in the *Annals of the Royal Botanic Gardens, Peradeniya*, VII, p. 57 (1919).

In August, 1923, this species again sprang up in hundreds in a similar decaying clump of the same bamboo, and as the specimens appeared to present some peculiar features, they were critically compared with the former collections, and with the descriptions and figures of *Mutinus bambusinus*. The gathering of 1923 proved to be the same as those of previous years, but it was found that none of them quite agreed with the published accounts of *M. bambusinus*. Except in one particular, the general appearance of the fungus is the same as that of the latter species, but the structure of the head differs from that described and figured for *M. bambusinus*.

The "eggs" occur in dense clusters. They are small, considering the size of the expanded fungus, oval, about 3·5 cm. high and 2 cm. diameter, sometimes covered above with a grey, tomentose layer, which splits into patches as the egg increases in size.

The expanded fungus (receptaculum) is fusoid in shape and up to 16 cm. high, the head being about one-half the total height. The lengths of stalk and head respectively in a series of specimens were 8 cm., 8 cm.; 8 cm., 7 cm.; 8 cm., 6 cm.; 6 cm., 6 cm.; 5 cm., 7 cm.; 5 cm., 6 cm. The greatest observed difference between the lengths of the stalk and the head was in a specimen 15 cm. high, in which the stalk was 9·5 cm. and the head 5·5 cm.

The stalk is 0·9–1·2 cm. in diameter, attenuated downwards into the volva. It is pinkish above, fading into white below, hollow, with a wall composed of a single layer of large chambers, the exterior walls of which are frequently perforated, while the interior walls are continuous.

The head is elongated conical, sharply defined from the stalk. The diameter of the head, at its junction with the stalk, is

greater than that of the latter, either slightly greater, or exceeding it by 2 mm. The head is not covered with gleba up to the apex, but usually terminates in a sterile tip, up to 5 mm. long. Examples with a bifurcated apex (Plate XV, fig. 2) are not uncommon. When bearing the gleba, the head is dark red or brownish red, but after the gleba has been washed off it is bright crimson. The sterile tip is pinkish in colour, and of the same structure as the stalk. It may be perforated at the apex or not. In general, it is perforated, often laterally compressed with the two sides in contact. In some examples, the tip is almost suppressed, and the head then appears truncate.

The structure of the head differs from that of *Mutinus caninus* and *M. Fleischeri*. The wall is red throughout as in those species, and as in them it has a single layer of large chambers, generally widely perforated on the inner side. But it differs, in that the outer surface bears irregular parenchymatous processes, simple or variously branched, attached to the head and more or less perpendicular to the wall. These are evident in the photograph on Plate XV, fig. 1. The large chambers in the lower part of the figure correspond with those of the head of *M. Fleischeri*, while the processes above are an additional feature, not existing in the latter species. Consequently, whereas the head of *M. Fleischeri* is smooth externally, that of the present species is rough or granular when fresh, or somewhat spongy when drier.

The gleba is dark olive. On small examples, it may form discontinuous, dark olive patches. But, owing to the enormous elongation of the head on expansion, the gleba is usually spread out in a very thin film which does not completely hide the red colour of the underlying tissue. The gleba in the expanded fungus lies to a great extent between the processes of the head. The spores are cylindric or oblong-oval, 2–4 × 1 μ.

The odour of the fungus is strong, but not unpleasant. It resembles that of some decaying fruits. There is a slight foetid odour apparent when the plant is held very close, but if two or three specimens are kept in a room only an extremely strong, fruity smell is perceptible.

The points in which this fungus appeared to differ from *Mutinus bambusinus*, according to the published descriptions of the latter, are (1) the sterile apex of the head, (2) the structure of the glebiferous region, (3) the colour of the head, and (4) its odour.

The sterile tip is not an accidental feature, due merely to absence of the gleba, as it differs in structure from the glebiferous part of the head.

The descriptions and figures of *Mutinus bambusinus* suggested that that species is a *Eu-mutinus*, with a head similar in structure

to that of *M. caninus*. In the Ceylon species, the head is rough, and similar in character to that of *Pharus Gardneri*, *Clautriavia irpicina*, and the *Rugulosi* section of *Ithyphallus*, though the processes are not so stout as in the first two species. But no details were available concerning the nature of the head in expanded specimens of *M. bambusinus*.

Zollinger's description of *M. bambusinus* (*fide* Fischer) was "Volva coriacea sordide albida irregulariter lacerata, interiore breviore tenuissima alba; stipite tereti roseo deorsum tenuiore et pallidiore elastico cribroso, capitulo stipiti contiguo conico acuto impervio tuberculoso intense purpureo." This agrees with the Ceylon species in shape, having a conical head and a stalk attenuated downwards, and in the colour of the stalk; but it differs in its deep purple, tuberculate head. Whether the apex is closed or open may not be a material character. Zollinger's specimens were collected among dead bamboos at Buitenzorg in Java.

Berkeley recorded *M. bambusinus* in *The Intellectual Observer*, IX (1866), with a copy of a figure by Kurz who had collected the specimens in Java. He stated that it had an elongated conical, subacute receptacle (*i.e.* head in this instance), strongly papillose and of a deep purple-red, and a rose-coloured stem.

In 1885, Fischer published an account of *M. bambusinus* in *Ann. Jard. Bot. Buitenzorg*, VI, based upon material, preserved in alcohol, which had been collected in the bamboo grove of the Botanic Gardens, Buitenzorg, by Solms-Laubach. Fischer described the stalk as pale brownish red and the head as dull purple. In alcohol, the Ceylon fungus retains the crimson colour of the head for some time, while the stalk becomes white. The surface of the head was wrinkled tuberculate, and the length of the head was equal to or greater than that of the stalk. The head was elongated conical, almost of the same diameter below as the stalk. The stalk was cylindric, with a wall composed of a single layer of large chambers, often perforated externally. The structure of the head was similar, but the internal, not the external walls of the chambers were perforated. [This difference is general in *Mutinus*.] The apex of the head was not perforated.

Fischer's figure of the receptaculum (No. 29) shows a specimen 10·5 cm. high, with an elongated conical head, terminating in an acute apex. The head is slightly greater in diameter than the stalk at the junction of the two, and is about one-half the total height of the fungus. The stalk is almost uniformly cylindric. The head is marked with polygonal areas, the outer walls of the chambers of which it is composed. Fischer's description as "tuberculate" apparently refers to these convex outer walls. There is no indication on the figure or in the description of any

projecting processes on the head. But fig. 31, which shows a section of a developing head, strongly suggests that the outer walls of the chambers of the head bore projecting processes in that specimen.

In 1888, Cooke recorded the occurrence of *Mutinus bambusinus* in Britain, specimens having appeared in open ground among young plum trees in Noble's Nursery at Sunningdale. He stated that the fungus had a very strong foetid odour, whereas *M. caninus* was inodorous. The whole fungus was 10 cm. high, and according to Cooke's account the head was acutely conical and half the entire length. But that is so greatly at variance with his figures that it would appear that his description is chiefly a translation of Zollinger's.

Cooke gave coloured figures, including copies of Kurz's drawings and drawings of the British specimens by Massee. Kurz's figures show one specimen just breaking through the volva, and another in which the head has emerged but the stalk is not fully expanded. In the latter the head is 3·3 cm. long and the stalk (at most) 2·5 cm. It is difficult to imagine how Kurz obtained specimens in that state. He must have risen very early in the morning to collect them in that condition, and even then expansion would have continued while he was drawing them. The only explanation which appears at all probable is that the specimens were collected in the egg stage, and began to expand next morning while lying indoors, but had not sufficient moisture to enable them to complete their expansion.

Massee's figure *h* bears some resemblance to *Mutinus bambusinus*, though the head is short, about one-half the length of the stalk, and too convex. But figure *i*, which shows an ovato-conoid head about one-quarter the length of the stalk, is quite unlike any other figure of *M. bambusinus*.

Fischer, after an examination of these British specimens in Herb. Kew, was of opinion (1893) that they were only *Mutinus caninus*. There seems to be no doubt that they are not *M. bambusinus*.

In 1890, Fischer described a new species, *Mutinus Muelleri*, from Brazil, which is apparently closely allied to *M. bambusinus*. It had a conical head and a cylindrical stalk, the length of the head being about one-fourth to one-fifth the length of the stalk. The total height of the fungus was from 2 to 8 cm. The stalk was white or reddish and the head dirty purple-red. From the figures, it would appear that the glebiferous layer extended to the apex, and the apex was generally truncate. The surface of the head was transversely wrinkled, evidently different from that of the stalk, and often sharply limited from the latter by a definite constriction.

Fischer claimed that *Mutinus Muclleri* differed from *M. bambusinus* in the relative lengths of the head and stalk, the colour of the stalk, and in that in *M. bambusinus* the chambering (Kammerung) of the head was less different from that of the stalk than in *M. Muclleri*. Fischer states that in *M. Muelleri* the outer walls of the chambers of the stalk are composed of two to three cell layers, and those of the head of six cell layers, while in *M. bambusinus* the outer walls of the stalk chambers have two to four cell layers and those of the head four to six.

Möller, in 1895, described the same fungus, which he found growing among bamboos in Brazil. He disagreed with Fischer's identification and referred it to *Mutinus bambusinus*, after comparison with the specimens from Java in the Berlin Herbarium which had been examined by Fischer. According to Möller, the fungus may attain a height of 11 cm. and the ratio of the lengths of head and stalk is variable, from one-fifth to a half. The stalk is white, and the head dirty purple-red. The apex is always perforated.

Möller's photograph shows a specimen with a cylindrical stalk and a conical head, the apex being distinctly truncate. A well-marked furrow divides the stalk from the head. The surface of the head is covered with gleba, but the photograph gives the impression that the head is tuberculate under the gleba, the tubercles being the convex outer walls of the chambers of the head. The wall of the stalk is not perforated.

Fischer investigated the young stages of *Mutinus Muelleri*, and found that, contrary to what occurs in *M. caninus*, the tissue which lies between the gleba and the head formed in this species loose spherical cells, and his figure (27) shows these cells in contact in irregular rows. He also made comparisons with the young stages of *M. bambusinus* from Java, and found that the latter had essentially the same structure, but that the spherical cells were less strongly developed. In his key to the identification of the species, Fischer distinguished *M. Muelleri* by its having in the young stage numerous spherical cells between the receptaculum and the gleba.

Fischer stated, with regard to *M. Muelleri*, that when the fungus expanded, the gleba lay directly on the zone formed by the spherical cells, and the latter rested upon the head. But when the spore mass ran off, the spherical cells also for the most part disappeared, so that on examination of specimens which no longer bore gleba, the head was for the most part not covered by loose pseudoparenchyma cells.

Möller stated that spherical cells, loose or united into small parenchymatous masses, occurred in greater or smaller quantity

between the gleba and the head in *M. Muelleri*, but that the amount of these varied in different examples.

Mutinus boninensis, described by Fischer from specimens from the Bonin Islands, is not very different from *M. bambusinus*, according to the figures and description. In its young stage, before expansion, it has a parenchymatous layer between the gleba and the head, which forms a continuous layer over the latter; but what becomes of this layer on expansion was not recorded.

In a recent note on *Staheliomyces cinctus*, Fischer again discusses the processes of the head which occur in several species of phalloids, especially in *Clautriavia irpicina*, and states that in *Mutinus Muelleri* the region between the gleba and the head consists of a loose tissue similar to the pseudoparenchyma of the head.

Penzig, in his paper on the phalloids of Java, stated that *Mutinus bambusinus* was common in Java, but that he refrained from describing it as it was already well known. That was somewhat unfortunate, as he was the first investigator of phalloids who had an opportunity of examining the Javan species in a fresh state.

As regards the odour of these fungi, Möller stated that the odour of *M. Muelleri* was not specially strong and resembled that of fresh horse dung. He also quoted Solms-Laubach that the odour of *M. bambusinus* in Java was weak and very offensive, resembling that of human excrement. Cooke recorded that the alleged British specimens of *M. bambusinus* had a very strong foetid odour, whereas *M. caninus* was inodorous. The Ceylon specimens have a strong odour, but it is not offensive and resembles that of decaying fruits. It is to be expected that opinions on this character will be as varied as those on colours, but nevertheless the recorded observations differ so widely that one would not expect them to relate to the same species.

The colour of the head in *M. bambusinus* is said to be deep purple by Zollinger, and dull purple by Fischer. Möller stated that the head of *M. Muelleri* was dirty purple-red. Fischer recorded that the head of *M. boninensis*, as far as could be determined from specimens preserved in alcohol, was dull red. In the Ceylon specimens, the head, when covered with the gleba, is dark red or brownish red, but after removal of the gleba it is bright crimson.

Whether the perforation of the apex in *Mutinus* is a valid character or not, depends upon the structure of the species. In some species of *Mutinus*, *e.g. M. Fleischeri*, the glebiferous layer extends *over* the apex, and in this species the apex is truly imperforate. On the other hand, in the Ceylon species

under discussion, the glebiferous layer does not extend to the apex, and the tip of the head is composed of tissue of the same nature as that of the stalk. In the latter species the apex may be perforated or not. Möller stated that the apex of *M. Muelleri* was always perforated; the truncate apex shown in his photograph supports his contention, and Fischer's figures show a perforated apex. A similar truncate apex is figured by Fischer for *M. boninensis*. On the other hand, Zollinger described the apex of *M. bambusinus* as imperforate, and Fischer describes and figures an imperforate apex in that species. The difference depends upon the structure of the head. In some species, the glebiferous layer is a continuous conical cap, and in these the head is consequently imperforate; in other species, the glebiferous layer is a cylinder with open ends, and in these the head is perforated at the apex, or is closed by a tissue different from that of the glebiferous layer and resembling that of the stalk.

To decide the identity of the Ceylon species, application was made to Dr C. Bernard, of Buitenzorg, for specimens of *Mutinus bambusinus*, and through his friendly offices, Dr C. van Overeem kindly forwarded examples of that species in alcohol. An examination of these furnished somewhat unexpected results.

The general stature of the Javan specimens is the same as that of the Ceylon examples. One is 7 cm. high, with a head 3·5 cm. long; another, 9 cm. high, has a head 5 cm. long; and a third, 5 cm. high, has a head 1·5 cm. long. The diameter of the head is slightly greater than that of the stalk. In all three, the glebiferous layer does not extend over the apex. The two larger have a distinct sterile tip, while in the smallest the tip is almost suppressed. In two examples the apex is closed, but in the third it is open. Two have lost their colour in alcohol, but the head of the third is bright red. The outer wall of the stalk is perforated.

In one specimen, the head bears irregular processes similar to those of the Ceylon form, but they are not so strongly developed. Here and there they appear to be wanting, so that the outer walls of the chambers of the head are visible as small pulvinate elevations. But on examining these areas with a lens it is seen that they are very minutely granular. In the other two specimens the head appears smooth, and merely bullate and transversely wrinkled, as in *M. Fleischeri*, but on close examination it is found to be minutely granular and to have remains of the processes scattered over the head.

In the Ceylon specimens, the lateral walls of the chambers of the head nearly all attain the same level, so that the inner surface is even, with numerous perforations. In the Javan specimens, the walls of some of the chambers are shorter than

the others, so that when viewed from the inner side, the surface presents numerous large cavities, with a network of ridges at the base. This, however, is not universal in the one specimen, and some sections show a structure exactly the same as that of the Ceylon forms. The walls of the chambers of the head tend to be thicker in the Javan specimens than in the Ceylon ones.

A section of part of the head of a Ceylon example is shown on Plate XVI, fig. 1. Below are the chambers of the head, one of which is closed and the others perforated on the inner side. External to this layer (above in the figure) are numerous parenchymatous masses, with darker masses of gleba between them. These are the sections of the processes, and here and there they can be seen to be attached to the outer wall of the head. They arise from the wall of the head as a sheet of tissue, which divides above into lobes more or less parallel to the head. Hence, in section, some pieces appear to be attached by a definite stalk, while others are sections of the lobes and appear to be loose. The outer surface of the wall of the head is the continuous line across the figure, its angular outline being due in part to contraction in alcohol. When fresh and expanded, the outer walls of the chambers are convex.

Fig. 2, Plate XVI, shows a similar section of a Javan specimen. It will be noted that the walls of the chambers are, in places, thicker than those of the Ceylon specimen, though they vary greatly in that respect. The external processes are feebly developed, and are absent for a short length in the middle of the figure.

Fig. 3, Plate XVI, is another section from the same serial series as the last. In this section, the lateral walls of the chambers on the left are as long as those of the Ceylon specimen, but in the centre they are much shorter. It will, however, be evident from the two sections that this variation in the length of the lateral walls is not a constant feature of the Javan form; and it is not a distinguishing character between the Ceylon and the Javan forms, as it occurs, on a less extensive scale, to the left of the section of the Ceylon example.

Fig. 4, Plate XVI, is a section of another Javan specimen, the head of which appeared smooth. In this the walls of the chambers are short and massive. It is to be noted that all the photographs of sections are taken with the same magnification. The processes in this case are distinguishable only with difficulty. They are almost in contact with the outer wall of the head, with a thin layer of gleba beneath them. The interrupted black line in the figure is the gleba, the processes forming comparatively large parenchymatous masses external to that.

It will be evident that the structure of the head is the same

in both the Javan and the Ceylon examples, the differences being merely of degree. In the available examples of the Ceylon form, the processes of the head are strongly developed and crowded together, so that the outer wall of the head is not visible and the head appears rough when the gleba is removed. In the Javan form, the processes are, in general, not so strongly developed, and they may be widely scattered, or absent over certain areas, so that the head may appear smooth, bullate, and transversely wrinkled, when the gleba is removed.

According to Fischer, the processes on the head of such phalloids as *Clautriavia*, etc. are of the nature of paraphyses, which penetrate between the trama plates of the gleba. Some species do not possess them, and consequently their heads are smooth when the gleba ripens. It would also seem probable that, in those species which possess these paraphysoid structures, the latter might be involved in the deliquescence which occurs in the gleba mass when ripe. In that case one would expect a variation in the degree of development, or rather in the extent of persistence, of these structures. The apparently smooth areas on the head of *Mutinus bambusinus* bear minute points which appear to be the attachments of vanished processes.

The Javan specimens of *M. bambusinus* examined were from Buitenzorg, near sea-level. The Ceylon specimens were from Peradeniya, at an elevation of 1600 ft. It would be of interest to determine whether specimens from the low-country of Ceylon more closely resemble the Javan examples, but up to the present the fungus has not been found in Ceylon except at Peradeniya. It is possible that the difference in mean temperature might have some effect on the development of the fungus, as regards the relative amounts of gleba and paraphyses, or on the deliquescence of parts of the fungus at maturity.

In view of the variation which occurs in *M. bambusinus* from the type locality, there can be little doubt that the Ceylon fungus must be referred to that species. Moreover, it would seem equally certain that *Mutinus bambusinus*, *M. Muelleri* and *M. boninensis* must all be regarded as the same species, the differences recorded being merely minor variations of the same structure.

There are two distinct types of structure of the glebiferous layer in the stalked phalloids. In the one type, the head is glabrous, either tuberculate, or regularly reticulated with raised bands. In the other, the head is covered with irregular parenchymatous processes and appears granular. Examples of the two types, parallel as regards general shape, are afforded by *Dictyophora phalloidea* and *Clautriavia irpicina*; by *Lysurus australiensis* and *Pharus Gardneri*; by *Ithyphallus tenuis* and

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MUTINUS BAMBUSINUS

I. rugulosus. The difference is of generic value. It cannot, however, be ascertained until the gleba is removed, and hence many figures of phalloids do not afford sufficient evidence to enable them to be classified even generically.

Mutinus bambusinus, because of the comparatively feeble development of its processes, and their absence in some examples from at least part of the head, provides a link between the two types referred to above. But as the head is furnished with these parenchymatous processes, it should be classed in the second group, not in *Eu-mutinus*.

Penzig proposed the genus *Jansia* for certain species of *Mutinus* in which the head bears projecting appendages. In these species, the appendages are regular, hollow, finger-like outgrowths from the wall of the head, and quite different from the irregular, solid, parenchymatous processes of *Clautriavia irpicina*, *Mutinus bambusinus*, etc. It is not possible to include the present species in *Jansia*. Fischer (1900) placed *Mutinus boninensis* in *Jansia* (as a subgenus), but from his figures and description it differs in structure from Penzig's species.

[*Note*. It has been pointed out to me that the generic name *Pharus*, proposed by me for *Colus Gardneri* in *Ann. Perad.* VII, p. 59, has been applied previously to a genus of North American grasses. Following the usual practice, *Pharus* Petch may be replaced by *Mycopharus*.]

REFERENCES.

Cooke, M. C. *Mutinus bambusinus* in Britain. Grevillea, XVII, p. 17. 1888.

Fischer, E. Zur Entwicklungsgeschichte der Fruchtkörper einiger Phalloideen. Ann. Bot. Jard. Buitenzorg, VI, pp. 1–51. 1885.

—— Untersuchungen zur vergleichenden Entwicklungsgeschichte und Systematik der Phalloideen. Denkschrift der Schweizer. naturf. Gesellsch. XXXII, I. 1890.

—— Neue Untersuchungen, etc. Denkschrift der Schweizer. naturf. Gesellsch. XXXIII, I. 1893.

—— Untersuchungen, etc. III Ser. Denkschrift der Schweizer. naturf. Gesellsch. XXXVI, II. 1900.

—— Mykologische Beiträge, 27. Mitt. d. Naturf. Gesellsch. in Bern aus dem Jahre 1923, Hft. V. 1923.

Lloyd, C. G. *Mutinus bambusinus*. Mycological Notes, No. 37, p. 505. 1911.

Möller, A. Brasilische Pilzblumen. 1895.

Penzig, O. Ueber Javanische Phalloideen. Ann. Bot. Jard. Buitenzorg, Sér. II, I, pp. 133–173. 1899.

Petch, T. Gasteromycetae zeylanicae. Ann. Roy. Bot. Gard., Peradeniya, VII, pp. 57–78. 1919.

EXPLANATION OF PLATES XIV, XV AND XVI.

Plate XIV.

Mutinus bambusinus, gleba removed; natural size.

Plate XV.

Fig. 1. *Mutinus bambusinus*, gleba removed; natural size.

Fig. 2. Specimen with a bifurcated apex, gleba removed; natural size.

PLATE XVI.

Fig. 1. Section of the wall of the head of a Ceylon specimen.
Fig. 2. Ditto, specimen from Java.
Fig. 3. Ditto, same specimen as Fig. 2.
Fig. 4. Ditto, Javan specimen macroscopically smooth. All × 20.

FUSARIUM PALLENS (NEES) LINK.

By T. Petch, B.A., B.Sc.

THE present century has witnessed a notable development of what may be termed stock-taking in systematic mycology. The earlier mycologists, working in different countries and with scanty facilities for communication or publication of their descriptions of fungi, each in his separate star described the species which came under his notice, with the natural result that the same species might be described several times under different names. It cannot be claimed that the practice is obsolete at the present day; and a cursory examination of any critical monograph of a limited group of fungi will immediately show how extensive the resulting synonymy has become.

It has been truly said that when Saccardo completed the first eight volumes of the *Sylloge Fungorum* in 1889, the mycological world then had a basis on which to produce lasting work—but failed to rise to the occasion. It has been left to a later generation to attempt the task of weeding out superfluous names; and now that time has diminished the resentment with which the implication that there could be any errors in systematic mycology was at first received, it is becoming recognised that in the conditions under which the subject has grown up, mistakes were inevitable, and if it is to deserve rank as a science these mistakes must be rectified.

One of the chief obstacles in the way of attaining a stable nomenclature in systematic mycology (apart from generic changes) is the interpretation of the descriptions, and consequently the application of the names, of the pioneer mycologists. Descriptions in early days were usually brief, and were drawn up with a view to distinguishing between a few species. Consequently they are inadequate when distinctions have to be made between a score or more species. In some instances the early descriptions are, from the modern standpoint, practically generic descriptions. This of course was scarcely avoidable. It is not given to everyone to write with a knowledge of what will be required a hundred years hence.

In dealing with the species described by Berkeley and other mycologists of his era it is generally possible to decide what was

intended. Berkeley's descriptions are short, after the fashion of that period, and not always sufficient for a definite determination, but in nearly all instances a type specimen is in existence. Even if the type specimen is immature or fragmentary, it may be possible for a specialist in a particular group to recognise it, or for a worker in the district or country in which it was collected to match it with more perfect specimens.

Difficulties arise when, in an endeavour to ascertain the earliest name, we attempt to go further back and interpret the names given by the mycologists of the earlier years of the last century. In perhaps the majority of cases, there does not appear to be any type specimen in existence. In some instances, a trivial name has been generally adopted and consistently applied to one species since its first publication; and with such there is no difficulty. But in other cases, the name never came into general use—the fungus may not have been collected again—and there is consequently no traditional meaning attached to it. For practical purposes, these latter names are *nomina nuda*. Technically, of course, they are not; and if our list of fungi is to represent actual knowledge, it is necessary either to find species to fit them, or to discard them.

My opinion inclines to the view that such unattached names should be discarded. If, however, it is decided to bring them into use, the evidence in favour of their revival should possess a high degree of probability. The species to which it is proposed to apply the name should at least agree closely with the figure, if any, and with the description as far as the latter goes.

A recent publication affords a case in point. Wollenweber, in *Annales Mycologici*, XV, pp. 1–56 (1917), published the results of his examination of a large number of species of *Fusarium* in European herbaria, under the title, "Fusaria autographice delineata." The paper is merely a summary, giving lists of species found to belong to the genus *Fusarium*, with synonyms and generic changes as determined by Wollenweber from the specimens examined by him: the figures and the full data relating to the specimens being deposited in the Office of Cotton and Truck Crop Disease Investigations of the United States Department of Agriculture. Consequently an exact appreciation of the conclusions arrived at is not always possible. The chief point, however, to which it is desired to call attention is the replacement of the name *Microcera coccophila* Desm. by *Fusarium pallens* (Nees) Link, a change which has already passed into use in Europe.

Incidentally, it may be noted that this change abolishes the genus *Microcera* Desm. The type species of that genus is *Microcera coccophila*. Consequently, if *Microcera coccophila* is

merely a *Fusarium*, the genus *Microcera* Desm. lapses. But Wollenweber retains the genus for *Microcera Massariae* Pass. and transfers to it *Fusarium ciliatum* Link, while he accepts as *Microcera*, *Microcera Clavariella* Speg. *Tubercularia ciliata* A. and S. (*Atractium ciliatum* Link) has continuous subcylindric spores, $5 \times 2{\cdot}5\,\mu$; it has generally been regarded as a *Volutella*, *V. ciliata*. Link's genus *Atractium* had continuous spores, though he stated that he had seen septate spores in *Atractium ciliatum*. But the latter species is certainly not related to *Microcera* Desm. Again, *Microcera Clavariella* is a *Cladosterigma*, and differs completely from both *Fusarium* and *Microcera*. No single genus can possibly include *Microcera Massariae* Pass., *Volutella ciliata* (A. and S.) Fr. and *Cladosterigma Clavariella* (Speg.) v. H.

The following specimens are referred to *Fusarium pallens* by Wollenweber. The second column gives the host of the fungus in the specimen examined by him; the third, the name inscribed on the herbarium sheet; and the fourth, the herbarium or collection in which the specimen is to be found:

344. Cort. Acaciae horridae	Fusisporium coccinellum Kalch.	Cesati, Rome
345. Ram. Baccharidis dracunc.	Fusarium baccharidicola P. Henn.	Berlin
346. Cort. Lauri	Microcera coccophila Desm.	Berlin
347. Cort. Lauri nobilis	Microcera coccophila Desm.	Berlin
348. Cort. Lauri nobilis	—	Wollenweber
349. Cort. Populi nigrae	Fusarium pallens Nees	Cesati, Rome
350. Ram. Robiniae	Fusarium parasiton Fautrey	Upsala
351. Cort. ram. plantae ignotae	Pionnotes pseudonectria Speg.	Berlin

The data concerning the specimens unfortunately do not include the date or locality of the collection, nor the exsiccati names and numbers. No. 344 is apparently part of the original South African collection, and, as stated in *Trans. British Myc. Soc.* VII, p. 124 (1922), it is probably to be referred to *Microcera coccophila* Desm., though no perithecia have yet been seen from South Africa. But Nos. 346, 347, if, as is usual in European herbaria, these refer to the specimens collected at Florence in 1860-66, are the *Microcera* stage of *Sphaerostilbe aurantiicola*. It is, however, scarcely possible to distinguish these two in the absence of perithecia.

Dr C. Spegazzini has kindly furnished me with the type of *Pionnotes pseudonectria*. The fungus is growing on a scale insect (? *Chionaspis*) which is embedded in the bark and is not evident until the overlying fragments of dead bark are removed. The specimen contains numerous immature examples of a *Nectria* and well-developed synnemata of *Microcera*. It is *Sphaerostilbe flammea*, with its conidial stage, *Microcera coccophila* Desm.

The evidence for the substitution of the name *Fusarium pallens* for *Microcera coccophila* would appear to be that the

specimen under the former name in Cesati's herbarium at Rome is *Microcera coccophila*. But that is not the type specimen. It is quite possible that Cesati's specimen was wrongly named. If the type specimen of *Fusarium pallens* is in existence, it should be examined before that name is adopted; if there is no type specimen, it is necessary to consider very carefully the applicability of the description and figure to the species which is known as *Microcera coccophila*.

Fusarium pallens was described by Nees in *Nov. Act. Acad. Leop. Nat. Cur.* IX, p. 237 (1818), under the name *Atractium pallens*, with a figure, Table V, fig. 7. The description is as follows:

Atractium pallens, nobis. *Bleiche Kopfspindel.* A. erumpens, capitatum, stipite cavo subepidermide latente, capitulo subgloboso pallido cinerascente.—Icon. nostra Tab. V, fig. 7. Descriptio. Stipes cortici immersus, cavus, semilineam longus, ex cinereo subrufescens, intus obscurior, basi sua dilatata subepidermide sese expandit. Capitulum e ramulo prominens, ad speciem sessile, minutum, vix tertiam partem lineae diametro aequans, globosum seu compressiusculum, albido-cinereum, subpulverulentum. Microscopium compositum sporidia ostendit copiosissima aqua cito diffluentia fusiformia curvata pellucida septata, septulis circiter octo. In ramulo Alneo emortuo sparsim habitans legit in sylvula Weilensi prope Basileam Mense Aprili 1816. F. N.

The figure, a longitudinal section of the fungus and the host, shows the fungus erumpent from the bark, the latter being raised in a prominent cone, perforated at the apex. A sheet of fungus tissue, situated below the periderm and presumably surrounding the base of the cone, ascends to the apex of the latter, and emerges to form a globose pulverulent head. The head is thus sessile on the raised portion of the bark. Owing to the mode of formation of the sporodochium from a sheet of fungus tissue, a central core of cortical tissue is left in the middle of the base of the cone within the so-called stalk. Nees described the internal fungus tissue as an embedded stalk, hollow in the centre. It would appear more correct, in modern terms, to regard the sporodochium as sessile.

There is nothing in Nees' description or figure which can be considered applicable to *Microcera coccophila*, except that the conidia are fusiform and septate. The head of *Microcera coccophila* is not pulverulent, nor albido-cinereum; its stalk, when present, is not immersed, and the sessile examples, which are the usual form in Europe, are not connected with any fungus tissue within the plant on which the host insect is situated.

Consequently, unless an examination of the type specimen

proves that Nees' description and figure were chiefly products of his imagination, it is impossible to agree that *Fusarium pallens* is identical with *Microcera coccophila* Desm.

The following description of *Fusarium pallens* is given in Saccardo, *Sylloge Fungorum*, IV, p. 695:

Fusarium pallens Nees, Act. Acad. Leop. IX, pag. 237, t. V. 7; *Selenosporium pallens* Corda Icon, fung. I, pag. 7, *Fusidium obtusatum* et *pulvinatum* Link Obs. II, pag. 31, *Fusarium candidum*, Ehrenb., Sylv. 12, p. 24 (?).—Sporodochiis primo subcutaneis dein emersis, pulvinato-convexis, pallidis vel ex cinereo rufescentibus, basi dense cellulosis; hyphis repentibus complicatis; basidiis simplicibus vel parce ramulosis; ramulis fusoideis; conidiis fusoideo-falcatis, 3–5 septatis, 50 × 4·5–5, subhyalinis. *Hab.* in cortice putri ramorum Populi nigrae, Robiniae Pseudacaciae in Italia, Gallia, Arduennis, Belgio et Germania.

The literature at my disposal does not permit me to trace the origin of this description, nor the sources of the records of localities. It is probable that the specimen on *Populus nigra* was Cesati's and from Italy, and that this description is a combination of the original and details from that specimen.

Another of Wollenweber's conclusions which appears doubtful is the reference of *Fusarium coccidicola* P. Henn. to *Fusarium Detonianum* Sacc. The former was described by Hennings from specimens on a coccid on leaves of tea from East Africa. The latter was described by Saccardo from specimens on a decaying *Cyathus vernicosus* in northern Italy. Wollenweber did not examine the type of the latter, but cites a specimen on the stem of *Brassica oleracea* in his collection. As scale insect fungi, in general, are not found on other than insect hosts, this range of substrata is abnormal. *Fusarium coccidicola*, judging from the description, is most probably *Pseudomicrocera Henningsii*.

Microcera curta Sacc. is, according to Wollenweber, identical with *Fusarium larvarum* Fuck. As stated in *Trans. British Myc. Soc.* VII, p. 155, 1922, *Microcera curta* is not a *Microcera*, and it has been named several times, the earliest name then recognised being *Fusarium epicoccum* McAlp. It seems quite probable, from the description, that *Fusarium larvarum* is the same species; the latter was originally described as occurring on the chrysalides of insects, and the specimen may possibly have been on scale insects.

Under *Fusarium larvarum*, Wollenweber cites:

223. Chrysal. et larvis insectorum	Fusarium larvarum Fuck.	Herb. Saccardo
224. Cort. Lauri nobilis	Socia Microcera coccophila	Herb. Cesati
225. Ram. Tiliae platyphyllae	Microcera curta Sacc.	Berlin
226. ad fenestras sordidas	Fusarium merismoides Cda.	Berlin

The type specimen of *Fusarium larvarum* does not appear to have been examined. The specimen in Herb. Cesati is evidently one of the specimens of *Sphaerostilbe aurantiicola* collected at Florence in 1860–66, and these do contain a *Fusarium* with small strongly-curved spores which is morphologically identical with *Microcera curta* Sacc.

In the list of synonyms, *Fusarium larvarum* Fuck. is said to be synonymous with *Fusarium merismoides* Corda. The latter is the earlier name, 1838 as against 1869–70, and if the two are identical, it should presumably replace *Fusarium larvarum*. But in the list of *nomina conservanda*, Wollenweber includes both *Fusarium larvarum* and *Fusarium merismoides*. Perhaps the statement in the list of synonyms is an accidental error.

I am indebted to the Imperial Bureau of Mycology for the original description and a copy of Nees' figure of *Atractium pallens*.

ON THE IDENTITY OF RHIZOCTONIA LAMELLIFERA AND SCLEROTIUM BATATICOLA.

(With Plate XVII.)

By W. Small, M.B.E., M.A., B.Sc., Ph.D., F.L.S.

Introduction.

In a previous paper* the writer described a root disease of *Grevillea robusta*, tea, *Bixa Orellana*, *Coffea robusta* and *Casuarina equisetifolia* which was attributed to a *Rhizoctonia*. The fungus seemed to be a well-defined form confined to woody hosts and possessing characteristic sclerotia and structures which were called sclerotial plates, and it was placed in the genus *Rhizoctonia* in preference to *Sclerotium* for reasons which were thought to warrant the step and which were duly set forth. It was considered to be a new species and was named *Rhizoctonia lamellifera*. Since the original study of the supposed new *Rhizoctonia*, the writer has had an opportunity not only of investigating further occurrences of the fungus but also of studying side by side with *R. lamellifera* another sclerotium-forming fungus which was thought to be a different species because of its smaller sclerotia in nature and its lack of sclerotial plates. The latter was associated with a hot-weather wilt of French beans (*Phaseolus vulgaris* L.) and was identified as *Sclerotium bataticola* Taub., the cause of a sweet potato charcoal rot in U.S.A. An account of its occurrence has been published†. It has proved,

* Trans. Brit. Mycol. Soc. IX, p. 152 (1924).

† Kew Bulletin, 1925, 118.

however, to be indistinguishable in culture from *R. lamellifera*, and it is therefore advisable to withdraw the name *R. lamellifera* in favour of *S. bataticola*, which has a prior claim. The change of name implies the setting aside of the original reasons for preferring *Rhizoctonia* to *Sclerotium*; in other words, it means that strong likenesses between vegetative growths are considered of greater importance, at least in the meantime, than the presence of a supposed hymenophore, which was very imperfect and which has not been encountered a second time, and of clamp-connections which have proved to be very scarce.

The main purpose of this paper is to make known the change of name, and, at the same time, to record a large increase in the host range of the parasite. In the previous paper, stress was laid on the fact that the five known hosts were introduced plants. It was also remarked that the fungus was widely distributed in Uganda, and continued investigation has added weight to the truth of an observation which is in accord with what is known of the distribution of *S. bataticola* in other parts. It has been found in all the planting districts of the Protectorate except one that has not yet been searched. The list of hosts has been extended to include *Coffea arabica* L., three species of *Erythrina* (*indica* Lam., *umbrosa* H. B. and K. and *velutina* Willd.), two species of *Albizzia* (*moluccana* Miq. and *stipulata* Boiv.), cacao (*Theobroma cacao* L.), a species of *Sesbania* (probably *punctata* DC.), a garden croton (*Codiaeum* sp.), a species of *Eucalyptus* (probably *globulus* Labill.), two species of *Cupressus* (*macrocarpa* Hartn. and *Benthami* Endl.), a garden aster (*Callistephus* sp.) and a vetch from Palestine, the name of which is unknown. The *Phaseolus* already mentioned must be included, and it is probable that the rain tree (*Pithecolobium saman* Benth.) will prove to be a further host. The number of woody plants attacked is rather remarkable, for the majority of the hosts of *S. bataticola* in other countries are herbaceous. The fungus has recently been discovered on *Coffea arabica* in Kenya Colony, and there is little doubt that further investigation in these parts of Africa will reveal not only a larger area of distribution for it than is known at present but also an extended host-range. The action of the fungus on woody plants has continued to be slow. Several *Grevillea robusta* trees that are in its grip have been under the writer's observation for several years, and are dying by very gradual stages. That certain areas are infested by the *Sclerotium* is proved by its attack on more than one host in each; recently, five of the new hosts were found on a coffee estate which had already provided examples of the loss of *Grevillea* and *Bixa*. Attention may again be directed to the fact that none of the victims of the *Sclerotium* is indigenous to Uganda. The *Sesbania*

was imported from Kenya and is not, as far as the writer is aware, a native of equatorial Africa, and the other hosts were brought from further afield. The majority were destined to be ornamental plants or shade trees for coffee and cacao, and their loss is felt the more severely in that their deaths do not take place until the trees are old and large enough to fulfil their purposes.

The restriction of the attacks of the fungus to introduced plants has raised an important point with regard to infection. Cases of *Sclerotium* root disease of, for example, *Grevillea robusta* and *Albizzia moluccana* were found in districts where climatic and soil conditions were not alike, and it seemed therefore as if infection need not depend upon local circumstances. It may have been influenced to some extent by the morphological characters of the rootlets of the host plants, but the interaction between host and parasite which ultimately decided whether the former was to repel or give way to the attack of the latter is more likely to be of a physiological nature. A search for possible biochemical factors governing susceptibility to *S. bataticola* would be full of interest, and it might be expected to throw light on the apparent complete immunity of, for instance, the Para rubber tree (*Hevea brasiliensis* Müll.-Arg.) which has been introduced into Uganda and is grown in quantity in areas known to harbour the *Sclerotium*; on the partial immunity of *Coffea arabica*; or on the susceptibility of introduced *Coffea robusta* as contrasted with the immunity of the indigenous form. Cotton is a further example of an introduced plant which must have been exposed in a large measure to infection by the *Sclerotium* and which is known to be attacked by it in other parts. Besides possible physiological factors, two others may have been at work which account for its apparent immunity—the slowness of advance of the fungus and the compulsory uprooting and burning of plants after each picking season whereby the growth of Uganda cotton is really of an annual type and not perennial. To this enforced change in its mode of life and to the hygienic treatment of the field rubbish is due in great part the continued comparative scarcity of cotton diseases caused by parasitic fungi.

The present disease is an example of the bringing of hosts into contact with what is evidently a well-established parasite, the reverse of the perhaps better-known process of introducing a parasite into a new field, and it forms a parallel to another local case, that of the attack on an introduced plant, *Coffea arabica*, by the indigenous *Hemileia vastatrix* B. and Br. which occurs on native *Coffea robusta*. In the latter case, the passage of time and improvements in cultural methods seem to have

rendered *arabica* coffee more and more resistant to the attacks of *Hemileia*, but such a result can hardly be expected in the case of host plants which do not survive the attentions of the parasite. On this account, and because of the difficulty, if not the impossibility, of exterminating the fungus from large areas, the *Sclerotium* root disease is to be avoided rather than combated by direct means, a fact which has compelled coffee-planters and others to seek for shade trees among the indigenous flora which is presumably immune to the fungus.

The New Hosts.

Of the new hosts of *Sclerotium bataticola*, *Coffea arabica* is of greater economic importance than the others. It was mentioned in the course of the previous paper that the spread of *S. bataticola* from *Grevillea robusta* to *C. arabica*, the former of which is planted as shade and wind-break to the latter which is the staple crop on many European-owned estates, would have serious consequences. The same effects might be expected to follow on estates which had instituted wind-breaks of *Casuarina*. In the meantime, however, experimental attempts to infect young *Coffea arabica* plants with the fungus had failed, and, although losses of *Grevillea* and *Casuarina* trees due to the *Sclerotium* disease have continued to increase slowly, there is not yet any field evidence of the direct spread of the parasite from either of these hosts to coffee, despite the fact that diseased roots of the victims have been in intimate and prolonged contact with healthy roots of coffee. Similarly, the *Sclerotium* has had abundant natural opportunities of passing to coffee from *Albizzia* and *Sesbania*, but careful search has not revealed a single instance of infection by contact. It was supposed that a young tea plant and an arnatto affected by the *Sclerotium* had acquired the root disease through their proximity to diseased *Grevillea robusta**, but the examination of numerous examples of the new hosts of the fungus has not produced any evidence of its spread by contact. It seemed, therefore, that independent infection was the rule rather than the exception, and that the incidence of infection of woody plants was governed more by the degree of susceptibility of the host plant and the presence of the fungus than by such external conditions as control the health of the plants. The majority of the tree victims have done well for as many as five or six years before succumbing to the root disease. In herbaceous plants, again, environmental factors seemed to have a more immediate and more direct effect in determining infection and disease, for the outbreaks of *Sclerotium* disease of *Phaseolus*, asters and the Palestine vetch

* Trans. Brit. Mycol. Soc. *loc. cit.* p. 161.

occurred during hot dry spells and the collapse of the plants was rapid. The possibility of the operation of another factor, due to the existence of biological races within the species, is discussed later.

Sclerotium bataticola occurred on *Coffea arabica* in only two areas. The first instance comprised two young trees about a year old which were planted as replacements in an area in which had occurred both *Sclerotium* disease of *Grevillea* and the root disease of young tea. The fungus, therefore, was known to be present in the soil of the plantation. The diseased coffee plants, however, were not making normal healthy growth; both had been attacked by cutworms (*Agrostis* sp. or *Euxoa* sp.), and their root-systems were not only poorly developed but were handicapped by deformation of the tap-roots due to bad planting. Conditions, therefore, were favourable to the fungus, which seemed to have grasped its opportunity. In the second area, a large proportion of old trees in two plots which were bordered by a wind-break of *Casuarina equisetifolia* was in process of succumbing to the root disease. It was reported that the plots had not borne good crops, and it was only the disclosure of the presence of the *Sclerotium* on such of the sickly trees as were dug up that offered an explanation of the trouble. As several of the *Casuarina* trees in the borders of the plots had died of *Sclerotium* disease, it seemed probable that the fungus had advanced from those centres of infection into the plots of coffee. Such a supposition, however, was not supported by the facts, for affected coffee trees occurred irregularly throughout the plots and the coffee plants adjacent to the dead *Casuarina* trees were not necessarily diseased. Infection of the coffee and *Casuarina*, therefore, was to be regarded as having taken place independently, and it must be concluded that the soil of the two plots was more or less permeated by the fungus. The clearing of the land in question for the planting of coffee took place about eleven years ago, and, as there were no remains of the indigenous flora, it was impossible to attempt to trace the original source of the fungus. The roots of a dead indigenous tree in an area not far removed from the coffee plots under discussion were examined, but no trace of the *Sclerotium* was found upon them. It should be added that the land used for coffee-planting in this country was grass land rather than forest, that the dominant species in the plant association of such land was elephant grass (*Pennisetum purpureum* Schum.), and, further, that fungus root diseases of coffee have been of rare occurrence.

In the case of *Erythrina*, all three species were attacked in one large area which was originally under cacao, and, in addition,

velutina was killed in two other places. The seed of *indica* was obtained from India, and that of *umbrosa* and *velutina* from the West Indies. The cacao area had been abandoned as unprofitable, and it was only when it was cleared for the planting of coffee that the disastrous effects of the *Sclerotium* on the shade trees were fully realised. The *Erythrina* trees were in all stages of degeneration and decay. The wood of the roots was typically dry and brittle, and the disintegration of the inner cortical tissues was remarkably complete. On a certain coffee estate where *Albizzia* was extensively planted as shade, every tree of both *moluccana* and *stipulata* was either dead or dying. *Albizzia* was typical of the full effects of the loss due to *Sclerotium* disease inasmuch as the trees did not die until they were from four to six or more years of age. *Ganoderma lucidum* (Leyss.) Karst. and *Polystictus occidentalis* (Kl.) Fr. occurred, but not frequently or regularly, on dead stumps of *A. moluccana*, and *Botryodiplodia Theobromae* Pat. could be found on occasional roots. The *Sclerotium* in *A. stipulata* had progressed along a rootlet, and its advance was arrested at the junction of the rootlet with a larger root. Large exudations of gum such as were associated with the disease of *Grevillea robusta* occurred upon the stems of *Eucalyptus* trees in the grip of the *Sclerotium*. The gumming was accompanied by external blackening and cracking of the bark, and the bark and cortex of diseased roots became a dry stringy mass. The affected plant of garden croton was enabled to survive for a time by the development of young roots above the older diseased roots, a process which was aided by the piling up of soil around the base of the stem after the well-known manner of native gardeners. *Cupressus Benthami* was the only example of the death of a host of the *Sclerotium* in the nursery; young plants were attacked and killed before they were more than a few feet in height. *C. macrocarpa*, on the other hand, succumbed only as a well-grown tree.

The discovery of cacao as a host of *S. bataticola* came about more by accident than by design during the examination of a rain tree suspected of root disease. The plot in which excavation was made had been under cacao with rain tree shade. The cacao, however, was not an economic success, and it had been replaced by coffee. Cacao was extensively planted in Uganda some ten years ago, but the crop has not done well. Various hypotheses have been advanced to account for its failure, and it was thought that the discovery of the *Sclerotium* on cacao roots which had been allowed to remain in the soil when the trees were removed might throw a fresh and interesting light on the problem of its degeneration. The most characteristic field feature of the ill-health of Uganda cacao has been the die-back

of the leading shoots on which could be found at times a species of *Colletotrichum* which, in turn, was invariably succeeded by the die-back fungus, *Botryodiplodia Theobromae* Pat. The latter frequently killed to the ground first one side and then the whole of the tree, and cacao in Uganda seemed to be particularly susceptible to the advance of that common tropical fungus once it had attained a footing in a twig or branch. At the same time, root parasites were kept in mind and were looked for, but, with the exception of a few cases of root rot due to *Armillaria mellea* Fr. and one case of root disease of a few young plants due to *Helicobasidium longisporum* Wakef.*—a new species which has not been found a second time—root disease was practically non-existent; at any rate, the known disease could not be held responsible for the large and general amount of die-back. As it was possible that *S. bataticola* had been overlooked in the past, certain cacao trees in areas which were known to contain the fungus were examined. For instance, in the area which yielded examples of attack on the three species of *Erythrina*, and also contained examples of the deaths of *Albizzia moluccana* from the same cause, the fungus was found on only one cacao tree out of six examined, all of which showed advanced stages of the effects of the die-back fungus and looked as if they might be in the grip of root disease. Judged, however, by a comparison between the amount of root obtained with the *Sclerotium in situ* and the total amount of the apparently healthy roots of the same tree, or by the marked scarcity of the fungus on the six trees examined, the *Sclerotium* did not seem, from the mechanical point of view, to be deeply implicated in the loss of the trees in question. It is possible, of course, that the fungus exercised a toxic action. As cacao areas known to harbour the *Sclerotium* are not numerous, it may be impossible to carry out the complete investigation which is necessary to throw light upon the part the fungus is suspected to play, but a comparison of the amount of die-back in cacao plots which are not known to shelter the fungus with that in an area such as the above would appear to show that die-back is more prevalent where *Sclerotium* is present. Experimental inoculations with the *Sclerotium* and *Botryodiplodia Theobromae* would probably lead to an exact estimate of the harm done by each fungus, and might prove that the former was of greater significance than the latter, which is only a weak parasite. The fact remains that the proved presence of *S. bataticola* must be assumed to have been one at least of the factors to which the degeneration of cacao in Uganda has been due.

As regards the morphology of the *Sclerotium* in the tissues of its new hosts, there is little to add to what has already been

* Kew Bulletin, 1917, 310.

published. In the two young coffee plants, sclerotia were very numerous in and under the bark of the collars, and the wood of the stems at the same points was permeated by mycelium of the usual dark brown colour. No clamp-connections were found in coffee tissues. The hyphae measured up to 7 μ in breadth, and were composed of cells which varied in shape and size after the typical manner of the fungus (fig. 1). The hyphae were found to pass along both wood parenchyma and fibres, but they were more plentiful in the cells of the parenchyma. Tangled masses of hyphae and extensions forming sclerotial masses were practically confined to the parenchyma cells, and, when hyphae were scarce, were not to be found in the wood fibres. Sclerotia were also numerous on the surface of the wood exposed by the cut-worm wounds which had been carried to points well above the soil by the growth of the plants. They appeared as minute black dots of the usual outlines, and measured on an average ·2 × ·15 mm. They were thus smaller than the sclerotia of the *Grevillea* fungus. In the older coffee trees, affected roots were always dry and brittle, and the absence of bark and cortical tissues in some disclosed the presence of sclerotia on the surface of the exposed wood. The sclerotia were larger than those of the young trees, and resembled in size the sclerotia of the fungus on previous hosts. They measured up to ·6 mm. in length, and were distinctly convex in shape when they protruded from their substratum. Black sclerotial plates occurred only sparingly in *Coffea arabica* roots, and no trace of a tissue resembling the supposed hymenophore described from *Grevillea robusta* was found. Fig. 2 is a drawing of a section of a sclerotial plate in the wood of a coffee root. It shows the typical shapes of the cells of the hyphae composing the plate, and it should be compared with fig. 3, which is a superficial view of a sclerotial plate occurring in the wood of a root of *Erythrina indica*. It was evident from the dried condition of the smaller coffee roots and the presence in and on them of sclerotia, and also from the fact that the mycelium of the fungus had not penetrated as far as the older roots or stems of the trees, that infection had taken place through the rootlets, a conclusion that was supported by a comparison of the condition of the roots of all the hosts of the fungus.

In *Erythrina*, the blue- or grey-black staining of the wood of affected roots due to the presence of numerous hyphae of the *Sclerotium* was remarkably clear, and the inner root cortex was frequently lined with black aggregations of hyphae resembling rhizomorphs and bearing in their course numerous small sclerotia. The supposed rhizomorphs had a structure similar to that of the sclerotial plates already described. The *Eucalyptus*

root material was remarkable for the complete disintegration of the inner cortical tissues and the large numbers of sclerotia to be found on the surface of the wood and in the cortex and bark of decaying roots. In the first position the sclerotia were free and could be easily removed on the point of a needle, and, in the last-named position, they shone, as it were, through the papery bark as groups of small black pin-heads. The sclerotia on the wood of small roots of *Eucalyptus* measured from ·06 to ·14 mm. in diameter and were spherical for the most part, while those in the cortex were larger and measured up to ·7 mm. The latter were also spherical and often protruded from the surface of the inner cortex. *Sesbania* root material resembled that of *Eucalyptus* in the large numbers and sizes of the sclerotia to be found in the cortical tissues, and in *Albizzia* material masses of sclerotia could be found in the bark and cortex of small roots. On the herbaceous hosts, the sclerotia were, on the whole, smaller and more regularly spherical than those of a woody substratum, and sclerotial plates were absent. The sclerotia of *Phaseolus* were of an average diameter of ·1 mm., and of aster and the Palestine vetch ·08 mm. There was considerable variation in both size and shape of the sclerotia of *S. bataticola* from the different hosts, but all were alike in colour, in structure and in oily content. The smaller sclerotia of herbaceous plants were paralleled by those of woody hosts like *Eucalyptus*, and the internal hyphae of all the hosts were strongly alike, especially in the woody plants, but the main morphological proofs of identity between a form that was named as a new species and was thought to be confined to woody hosts and *S. bataticola*, as it occurred on the herbaceous plants, were obtained by cultural studies of the various strains.

In the original account of *Rhizoctonia lamellifera*, certain anatomical characters and certain indications of the presence of the fungus, for example, the structure of sclerotia and sclerotial plates and the dryness and brittleness produced in affected roots, were emphasised as distinctive and diagnostic. The continued examination of infected material, particularly that of woody plants, has only served to throw those points into greater prominence, but it is necessary to add to them one other, viz. that infection had taken place independently and not by contact, a point on which the field evidence was very striking and clear.

New Strains of *Sclerotium bataticola* in Culture.

In the course of many attempts to isolate the *Sclerotium* from its new hosts, it was found that large fragments of root tissue of woody plants gave better results than small pieces. They

could be sterilised more easily, and it was an advantage to be able to pare them if and when contaminations appeared. Growths from fragments were obtained on filter paper moistened with 5–10 per cent. cane-sugar solution and in 1 per cent. agar in water. The latter medium was unfavourable to the growth of bacteria which were frequently difficult to avoid, even after careful surface-sterilisation of the material, and it was used in quantity in Petri dishes. The commoner contaminating fungi (a species of *Alternaria*, a Moniliaceous form and a *Fusarium*) preferred to grow on the surface of the medium, and, if the *Sclerotium* had begun growth in the medium, its hyphae could be cleanly and easily removed by first turning over blocks of the medium containing them. Hyphae growing upon filter paper were found at times difficult to transfer to another medium, but the difficulty could be overcome by allowing the culture to dry up and in that way inducing the production of the structures called cell-formations, which were comparatively large in size and irregular in outline and so could be easily picked up. Chlamydospores were obtained and utilised in the same way. The number of fragments of woody plants, however, from which the fungus was induced to grow, was remarkably small, and the writer has concluded that the hyphae in the tissues were not only short-lived but also sensitive to sterilising agents applied both with and without heat. The penetration of the latter was no doubt assisted by the organic changes brought about by the fungus in the wood and cortex of diseased roots, but, nevertheless, tissue fragments tested for growth without sterilisation proved to be barren in the majority of cases. On the other hand, there was no difficulty in isolating the fungus from herbaceous plants.

It was made clear in the previous account of *R. lamellifera* that neither fresh nor rested sclerotia had been induced to germinate, and it now falls to be recorded that growths of hyphae were obtained from sclerotia from three woody hosts of the fungus, *Coffea arabica*, *Eucalyptus* and *Sesbania*. In all three cases, the sclerotia could be readily detached from their substrata, and they were apparently in a more completely rested state than the sclerotia used in previous attempts. When placed on filter paper moistened with cane-sugar solution, the sclerotia from *Eucalyptus* and *Sesbania* germinated at once, and it was a simple matter to obtain single-sclerotium isolations from these hosts. The sclerotia from *Coffea arabica* gave no growth on the same medium, but germinated when glucose-lemco agar was poured over them. At the same time, coffee sclerotia placed directly in glucose-lemco agar germinated at once. In the three strains, the initial mycelial growth resulting

from the transfer of hyphae derived from sclerotia resembled closely that described in the previous paper. In twenty-four hours, the area occupied by the fungus around the points of inoculation was a circle of about 2 cm. in diameter which contained hyphae varying from 2 to 12 μ in thickness and from 25 to 50 μ in length of cells, and in three days a vigorous aerial growth of mycelium reached the upper glass of a Petri dish. Sclerotial formation followed in the medium in about seven days. The first sclerotia appeared on the larger and older hyphae. Fig. 4 shows the stage of sclerotial formation reached in a glucose-lemco agar culture of the *Coffea arabica* strain in twelve days. The young sclerotial norm in culture was more or less spherical in shape and 60–65 μ in diameter, and the irregular outlines of the majority of the sclerotia were due to what may be called extra growth which could be controlled to a certain extent by varying the moisture content of the medium. The hyphae of *S. bataticola* in certain media, and especially on potato plugs, became so dark and apparently pressed together that they simulated the formation of a sclerotial plate, but the latter never became prominent or persistent. The hyphae, moreover, were not noted to develop the typical morphology of the hyphae of a natural plate. When the sclerotia were mature, the hyphae in glucose-lemco agar cultures seemed to lose their contents and dark colour and eventually to disappear. When small agar blocks with mycelium and sclerotia were removed from cultures and placed for observation in Petri dishes or hanging-drop chambers, the growth of the hyphae continued on the glass and took a more tangled and wavy form than in ordinary circumstances. Sclerotial formation also continued, and young sclerotia developed under such conditions were more regularly globose and smaller (about 45 μ in diameter) than those produced in the nutritious medium. Cell-formations and chlamydospores were both formed. The former appeared to be a middle course between the formation of sclerotia and the development of simple chlamydospores, and the latter were formed in both chains and groups. Isolations of the *Sclerotium* from *Albizzia stipulata* were obtained from small fibrous roots containing hyphae and sclerotia, but direct growth from the sclerotia was not observed. In addition to the cultures obtained from the sclerotia of *Coffea arabica*, *Eucalyptus* and *Sesbania*, isolations were made from root fragments of each. It was noted that, in each of these four strains, the early period of intense and rapid development of sclerotia in culture was followed by the appearance on the surface of the medium of numerous tufts of hyphae, which were hyaline but grey-white in the mass and composed of comparatively thin-walled cells containing much oil and

resembling in shape the elements of sclerotial plates. At the same time, the surface of the medium became furrowed and wrinkled as if it were drying up. Fig. 5 shows the appearance of the hyphae in question. When a single hypha from a tuft was transferred to fresh medium, the resulting growth did not differ in any way from that of the isolations obtained by other methods, and sclerotial formation took place in the usual time and manner. Cell-formations and chlamydospores were found only in filter paper cultures and in growth on glass, and it seemed that their place was taken in the case of a solid medium by the hyphae under discussion. It may be added that the latter became dark with age.

Cultures of the various strains of *S. bataticola* isolated from both woody and herbaceous hosts were therefore obtained at different times from tissue fragments containing hyphae, from sclerotial plate tissue, from sclerotia, from pieces of the supposed hymenophore, from cell-formations and chlamydospores formed artificially and from the hyphae just mentioned, and in all cases they developed along identical lines. Successive parallel cultures of the new strains begun from a single sclerotium of each were set up on various media, the most frequently used of which were glucose-lemco agar and Dox's agar. Although there seemed to be slight differences in the initial vigour of the mycelial growth of the various strains on the same medium, it was found that the development of each, measured by the time and rate of formation of sclerotia, was alike, that no one of the strains was morphologically distinguishable from the others, and, further, that sub-culturing led to no apparent diminution in the vigour of mycelial growth and sclerotial formation. The Dox agar medium was made by adding $2\frac{1}{2}$ per cent. agar powder to Dox's solution, and it proved to be very suitable for the growth of *S. bataticola*.

In the previous account of this fungus, it was pointed out that the connection between sclerotial plates and sclerotia was established in cultures started from the plates, and that the converse relation between sclerotia and sclerotial plates had not been proved by experiment. In the media employed, only the pretence at sclerotial plate formation already mentioned was observed. The effort to form a plate, however, appeared to be distinct and worthy of encouragement, and experiments were therefore made with a more natural substratum of growth. Sclerotia and hyphae of the *Coffea arabica* strain were sown on sterilised wood blocks of *C. arabica* and *Grevillea robusta* which were kept in flasks. Growth of the fungus on the blocks was rapid and profuse, and small sclerotia of 60 μ diameter increasing after ten days to 90 μ were formed in great numbers.

The external growth on coffee wood was more profuse than that on *Grevillea*, and the depth of penetration of the former by the fungus was ·07 mm. in seven days. At the same time, the internal hyphae were forming flattened lens-shaped extensions which resembled the beginnings of sclerotia or sclerotial plates. After fourteen days penetration was found to have increased, and the hyphae of the fungus were seen to resemble in habit and morphology those found in nature. They had grown freely along medullary ray tissue and had filled the cells with hyphal extensions recalling sclerotial plate tissue. When some of the blocks were transferred from a moist to a dry atmosphere in a desiccator, it was noticed that the fungus developed the grey-white tufts of mycelium already described and figured. After six months, a proportion of the blocks was split open and examined. In both *Coffea* and *Grevillea* wood, penetration was so complete that the dark hyphae of the fungus could be followed with the naked eye. Sclerotial formation was plainly visible, but, although the hyphal extensions mentioned above were larger and more numerous than formerly, sclerotial plate formation resembling that occurring in nature could not be said to have taken place. A similar examination having similar results was made after twelve months. It is worthy of remark that the penetration of the fungus, judged by the extent of the formation of sclerotia and masses of hyphae, was eventually more thorough in *Grevillea* wood than in that of *Coffea arabica*. This result seemed to depend upon differences in structure and texture of the woods, and it agreed in its implications with the state of affairs in the field where *Grevillea robusta* has been much more susceptible to *Sclerotium* disease than has *Coffea arabica*. Although experimental proof of the connection between sclerotia and sclerotial plates was not obtained, there was no doubt that both structures belonged to the species *S. bataticola*. Typical hyphae and sclerotia were derived from fragments of the plates, and the morphology of the plates was not only *Sclerotium*-like to a strong degree but also constant and consistent.

The supposed hymenophore which was described in the previous paper occurred in association with a sclerotial plate growing over the wood of a diseased *Grevillea robusta* root, and it is the opinion of the writer that the fundamental function of the plates, if they possess any function at all, is concerned with the formation of a hymenophore. At the same time, all attempts to induce the formation of a hymenophore on the sclerotial plates of many of the woody hosts of *S. bataticola* by keeping root fragments in a moist atmosphere or in moist sand for a long period have failed. The discovery of the perfect stage of the fungus would lead to its removal from the genus *Sclerotium*,

and the presence of clamp-connections seems to point in a certain definite direction, while the fact that clamp-connections are very scarce in both nature and culture may be correlated with the theory advanced in the former paper that the scarcity and imperfect nature of the supposed hymenophore are the result of a gradual loss of function. However that may be and whatever perfect stage the fungus may prove to possess, the morphological resemblances between the vegetative growths of the strains in culture were so exact and consistent that there was good reason for identifying them all, temporarily at least, as *S. bataticola* and for ruling out any suggestion of the presence of more than one species among them.

Each of the seven new strains of the fungus was grown in mixed Petri dish cultures with itself and with the other six strains. It was found that, while the approach to each other of the growths in the halves of the dish gradually narrowed the no-man's land between them until it became a mere line, no real coalescence took place except in the case of strains grown with themselves. No *Corticium* or other stage of the fungus was found in any of the mixed cultures. At the same time, it was noted that certain strains consistently caused a prune agar medium to become black, while others left it transparent. The darkening of the medium was accompanied by a greater development of aerial mycelium. When further media were employed with a view to showing whether these growth characteristics were permanent or not, it was found that they varied with the media and that they could not be regarded as the expression of qualities inherent in the different strains.

Inoculation Experiments.

Inoculation and cross-inoculation experiments with strains of *S. bataticola* from *Coffea arabica, Sesbania, Eucalyptus* and *Albizzia stipulata* were attempted by two methods. In one, the fungus was introduced in large quantities into sterilised soil in tins in which plants were grown from seed, and, in the other, fungus and intended host seedlings were grown together in large tubes containing Richard's solution diluted from 1000 c.c. to 1500 c.c. by the addition of sterile distilled water. The host plants employed were *Coffea arabica, Albizzia moluccana* and *Eucalyptus globulus* and, as natural infection was desired, care was taken not to break or wound the roots of the plants used in the second method. By the soil method, infection of a single *Eucalyptus* seedling by the *Coffea arabica* strain was the only result attained. The remaining plants grew well, and were not infected after five months' growth. In the tube experiments, the fungus was shown to grow well in Richard's solution before

the seedlings were introduced, but the majority of the tubes became contaminated despite careful surface-sterilisation of the seedlings and many of the seedlings did not flourish. The *Sesbania*, *Albizzia stipulata* and *Eucalyptus* strains were induced to infect only *Coffea arabica* seedlings; positive results were therefore few, and no direct-inoculation results were obtained. Attempts were also made to infect cotton seedlings with the above strains of *S. bataticola*, but neither method yielded successful results. What little positive evidence was obtained from the experiments was against the existence of biological races in the fungus, despite the evidence from the field, where, for example, the *Grevillea robusta* or *Sesbania* or *Albizzia* strain appeared to be unable to infect coffee. Cross-infection in the field was determined by the interaction of host, parasite and environmental groups of factors, and the lack of cross-infection between, for example, *Grevillea* and coffee, was explicable on the ground that coffee was more resistant than *Grevillea* to the invasion of a fungus to which the trees were equally exposed. Again, the fungus need not have been at any given time at the stage of development that enabled it to infect directly or to pass easily from one host to another, and the difficulty of obtaining growths of it from diseased roots, especially those which had become dry and brittle, pointed to its being in a state of activity only in the region of its advance. Further, each strain of *S. bataticola* might be and apparently was a morphological entity, but it did not follow that it was at the same time a physiological entity in the sense that it was always capable of a certain, say, parasitic, behaviour. When due consideration was given to all the aspects of infection, the factors of greatest weight in determining field infection of either kind seemed to be, in the majority of cases, the presence of the fungus and the susceptibility of the host plant.

During the investigation of the hot-weather wilt of beans due to *S. bataticola*, which has already been referred to, the behaviour of four strains of the fungus (from Uganda beans, from India, from cotton in Egypt and from U.S.A. sweet potato charcoal rot) towards wounded and unwounded sweet potatoes was shown to be alike. Neither of the strains could penetrate the unbroken skin of the sweet potato, and all four, when provided with a wound entrance to the tissue of the tuber, caused a charcoal rot which corresponded with the original charcoal rot described by Taubenhaus. Similar experiments were made with the later strains of *S. bataticola*. The four woody plant strains (*Coffea arabica*, *Eucalyptus*, *Sesbania* and *Albizzia stipulata*) were employed at first, and it was found that none of them caused the charcoal rot ever with a wound entrance. The results

were unexpected, and the same potato was therefore tested with the original four strains mentioned above. It was again found that none of the strains caused the charcoal rot. The particular potato used in these trials, a hard brown-skinned one, was probably resistant to *S. bataticola* as a rot-producing agent, but it should be noted that the inoculum used was drawn in all eight cases from old cultures. A further experiment consisted of a similar test of a hard pink-skinned sweet potato in which the inoculum was drawn from young fresh cultures of the old and the new strains along with that derived from the Palestine vetch, a total of nine. All nine strains behaved with remarkable unanimity, for all caused typical charcoal rot in from sixty to eighty days. Apart from the question of the comparative susceptibility of the two types of potato, the difference in the behaviour of the old and the young inocula is usually expressed by saying that the strains in culture lose with age their ability to cause infection. They may thus be presumed to be genetically unstable, but modern research bears against such a view. The paucity of experimental results, the state of affairs in the field where, for example, it was difficult to postulate the existence of as many as seven biological races in one small area like that mentioned at the beginning of this paper and the apparent loss of the power of parasitism point rather to the existence of discrete physiological strains within any one isolation of *S. bataticola*.

Summary.

1. A parasitic fungus which was described as a new species under the name *Rhizoctonia lamellifera* mihi is now regarded as identical with *Sclerotium bataticola* Taub. and reasons for abandoning the former of these names are given.

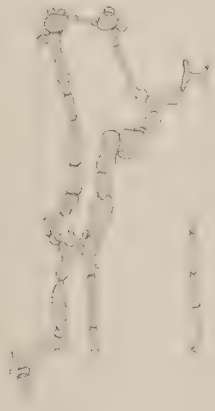
2. An extension of the host range of the fungus with particular reference to woody plants is reported.

3. Sclerotia from the tissue of woody hosts have now been germinated, but the sclerotial plates characteristic of the fungus in the roots of woody plants have not been obtained in culture, nor has the supposed hymenophore been found a second time.

4. Inoculation and cross-inoculation experiments have given only a few results. In the majority of cases, infection in the field seems to depend more upon the susceptibility of the host plant and the presence of the fungus than upon the factors which control environmental conditions.

EXPLANATION OF PLATE XVII.

Fig. 1. Hyphae in root of *Coffea arabica*. × 500.
Fig. 2. Sclerotial plate in wood of *Coffea arabica* root. × 500.
Fig. 3. Sclerotial plate in root of *Erythrina indica*. × 500.
Fig. 4. Sclerotia in culture of *Coffea arabica* strain. × 82.
Fig. 5. Hyphae from surface of medium. × 500.



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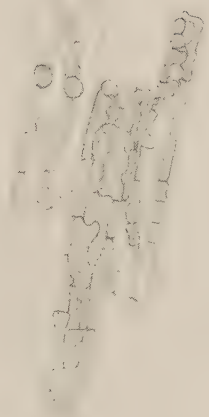

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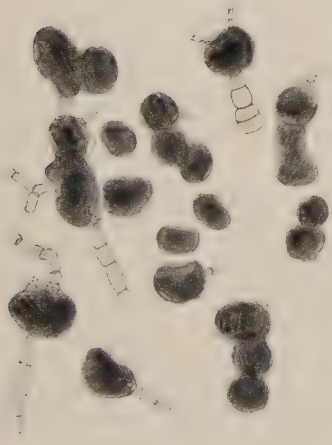

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5

SCLEROTIUM BATATICOLA

ON THE OCCURRENCE IN BRITAIN OF THE CONIDIAL STAGE OF SCLEROTINIA CYDONIAE SCHELL.

(With Plate XVIII.)

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In 1920 the present writer (11) recorded the occurrence in this country of the conidial stage of *Sclerotinia Mespili* Schell. This fungus was found causing dark brown, almost black, blotches on medlar leaves (*Mespilus germanica* L.), the infected areas eventually producing conidial fructifications of the *Monilia* type. A characteristic feature of the conidia was the presence of fusoid bodies known as "disjunctors*" which developed between, and separated, the spores in the chain. Later (12), an apothecial form developed from mummified flowers collected from underneath trees infected with the leaf blotch, and this form conformed with Schellenberg's description of the ascigerous stage of *Sclerotinia Mespili*.

On the Continent a closely related fungus is known to occur on the quince (*Cydonia vulgaris* Pers.) and, after the discovery of the medlar fungus, a search was made for the one parasitic on quince trees, but without success until the present year. An examination was made of a row of quince trees at the East Malling Research Station early in May, 1925, when a few leaves on several trees were found with blackened blotches similar to those previously seen on medlar trees, and it was suspected therefore that the quince leaves were infected by *S. Cydoniae*. On placing such leaves in a moist chamber spore masses developed in a few days and about the same time conidial fructifications were also found on diseased leaves on the trees. The conidia grew in moniliform chains and, like those of *S. Mespili*, were provided with disjunctors. These conidia were smaller and less spherical than those of the medlar fungus, but it was evident from the nature of the infection and the morphology of the parasite that the fungus was closely related to *S. Mespili* and that it was therefore probably Schellenberg's *S. Cydoniae*.

The fungus causing these symptoms on quince leaves has been known on the Continent since 1888 when Briosi and Cavara (2) gave the name *Ovularia necans* to a fungus said to occur on the medlar and the quince. In 1892 Prillieux (6)

* The structure and development of disjunctors has been described by Woronin (13) in his paper on *Sclerotinia Vaccinii*.

described the quince disease and referred the parasite to *Monilia Linhartiana* Sacc., a fungus found by Linhart on *Prunus Padus*; in the following year Prillieux and Delacroix (7) found the ascigerous stage and named it *Ciboria* (*Stromatinia*) *Linhartiana*. Woronin (14) in 1895 showed that *Monilia Linhartiana* Sacc. was the conidial stage of his *Sclerotinia Padi*.

Schellenberg (8) found that the quince fungus was distinct from that occurring on *Prunus Padus*, and therefore suggested the name *Sclerotinia Cydoniae* for it; he also found (9) that it was distinct from that found on the medlar. In a recent paper (10) he maintains the distinction between these fungi biologically as well as morphologically, for he finds by inoculation experiments that *S. Cydoniae* and *S. Mespili* are confined each to its own particular host. Berkhout (1), however, records the occurrence of *S. Cydoniae* on both quince and medlar in Holland*.

Sclerotinia Cydoniae, under that name or as *S. Linhartiana*, has been found in various localities on the Continent; in addition to the authors mentioned above, Pieper (5), Osterwalder (4) and Naidenov (3) record it.

As *Sclerotinia Cydoniae* appears to be hitherto unrecorded for Britain, a brief description of observations made at East Malling may be of interest to workers in this country. On the diseased leaves examined, only one infected area was seen on each leaf (fig. 1), but eventually the infected portion extended over the whole leaf which became brown and withered. Sometimes the infection extended from the lamina along the petiole and into the axis of the shoot so that the whole shoot wilted. The conidia were produced on the upper surface of infected leaves in grey tufts which, however, soon became more or less confluent to form an almost continuous layer. The conidial fructifications were at first limited to the regions bordering on the midrib and the main veins (fig. 2), but later they became more generally distributed.

Infected leaves emitted an aromatic odour which was very noticeable on removing the lid of a large Petri dish which served as a moist chamber in which diseased leaves had been kept for a day or two. A similar odour is given off by medlar leaves infected with *S. Mespili*. Woronin (13) in 1888 described the leaves of the Cowberry (*Vaccinium Vitis-Idaea* L.) infected with *Sclerotinia Vaccinii* as giving off "einen angenehmen, mehr oder minder intensiven Mandelgeruch," and stated that insects were attracted by the odour to the infected leaves and carried the conidia of the fungus to the stigmas of the flowers,

* The writer had the opportunity of examining a medlar leaf sent by Miss Berkhout and found that the dimensions of the conidia were of the same order as those of *S. Cydoniae* (see below, p. 305).

which in turn became infected. Schellenberg suggests that the odour emitted from infected medlar and quince leaves has a similar function.

The two fungi found on quince leaves and medlar leaves are obviously closely related. There is a marked difference, however, in the size of the conidia of *S. Mespili* and *S. Cydoniae*. Schellenberg (9) gives the dimensions of the conidia of *S. Mespili* as $15 \times 18–20\,\mu$; the writer (11) found them to be $10{\cdot}5 \times 12–20{\cdot}5 \times 25\,\mu$ (mostly $16–20 \times 18–22\,\mu$, with an average of $17{\cdot}1 \times 19{\cdot}3\,\mu$). Schellenberg's figures (8) for the conidia of *S. Cydoniae* are $7 \times 12\,\mu$, while the fungus at East Malling was found to have conidia rather larger, the range of size being $9–14 \times 10–21$, the great majority (about 90 per cent.) coming within the limits $9–12 \times 11–15\,\mu$, the average size of a hundred conidia being $10{\cdot}5 \times 13{\cdot}1\,\mu$.

About the same time that the fungus was discovered at East Malling, Mr W. J. Dowson found a similar fungus on quince leaves at Wisley. Mr Dowson kindly supplied specimens for comparison, and the fungus was found to be identical with that found at East Malling, the majority of the conidia again coming within the range $9–12 \times 11–15\,\mu$.

Whether the divergence, shown above, from Schellenberg's figure is a specific one or due merely to environmental factors will probably not be ascertained until the ascigerous stage is found in this country, but in view of the degree of specialisation found by Schellenberg (10) in these Sclerotinias the fungus on quince leaves which has been found at East Malling and at Wisley must be referred at present to *Sclerotinia Cydoniae*.

Berkhout (1) gives the dimensions of the conidia of *S. Cydoniae* as $10–11 \times 11–12\,\mu$, and measurements, made by the writer, of conidia from a medlar leaf (sent by Miss Berkhout in 1922) infected presumably by *S. Cydoniae* (see above, p. 304) were found to be $5{\cdot}5–12{\cdot}5 \times 6{\cdot}5–15\,\mu$ with an average (100 conidia) of $8{\cdot}5 \times 10\,\mu$. These figures are nearer to those given by Schellenberg.

The fungus has been isolated and grown in pure culture but detailed cultural studies have not yet been made. Like *S. Mespili* it grows very slowly on prune juice agar and on sterilised potato; on prune juice agar it produces numerous pustules of "microconidia," but no macroconidia.

The writer desires to express his indebtedness to Miss E. M. Wakefield for notes on the earlier papers referring to the quince disease, to Miss C. H. Berkhout of the Centralbureau voor Schimmelcultures, Baarn, Holland, for sending specimens from Holland, and to Mr W. J. Dowson for supplying infected quince leaves from Wisley.

Summary.

1. The occurrence of the conidial stage of *Sclerotinia Cydoniae* Schell. on quince leaves at East Malling, Kent, and at Wisley, Surrey, is recorded.

2. The dimensions of the conidia were found to be rather greater than those given by Schellenberg.

REFERENCES.

(1) Berkhout, Christine M. De Schimmelgeslachten Monilia, Oidium, Oospora en Torula. Thesis, University of Utrecht, 1923. [*Sclerotinia Cydoniae* discussed on p. 35.]

(2) Briosi, G. e Cavara, J. I funghi parassiti della pianti coltivate od utiles. Fasc. v, No. 110. *Oyularia necans* Pass. 1888.

(3) Naidenov, V. Die Mumienbildung der jungen Quitten, eine für Bulgarien neue Krankheit. Zemled. Spisan. na Belgarsk. Zeml. Drucksechstwo. xx, pp. 190–91. 1915. [Abstr. in Cent. f. Bakt. 2 Abt. lv, p. 186. 1922.]

(4) Osterwalder, A. Die Blattfleckenkrankheit der Quitte. Schweizer Zeitschr. f. Obst- u. Weinbau, p. 257. 1917.

(5) Pieper, A. Die Moniliakrankheit der Quitten (*Monilia Linhartiana*). Zeitschr. f. Obst- u. Gartenbau, p. 87. 1912.

(6) Prillieux, E. Sur une maladie du cognassier. Bull. Soc. Bot. Fr. xxxix, pp. 209–12. 1892.

(7) Prillieux, E. et Delacroix, G. *Ciboria* (*Stromatinia*) *Linhartiana*, forme ascophore de *Monilia Linhartiana* Sacc. Bull. Soc. Mycol. Fr. ix, pp. 196–200. 1893.

(8) Schellenberg, H. C. Ueber die Sclerotinienkrankheit der Quitten. Berichte Deutsch. Bot. Gesellsch. xvii, pp. 205–15 1899.

(9) —— Ueber *Sclerotinia Mespili* und *Sclerotinia Ariae*. Cent. f. Bakt. 2 Abt. xvii, pp. 188–202. 1907.

(10) —— Infektionsversuche mit Vertretern der Gattung Sclerotinia. Actes Soc. Helvetique Sci. Nat. civ, pp. 161–2. 1923.

(11) Wormald, H. On the occurrence in Britain of the Conidial Stage of *Sclerotinia Mespili* Schell. Ann. Appl. Biol. vii, pp. 173–7. 1920.

(12) —— Observations on a Discomycete found on Medlar Fruits. Trans. Brit. Mycol. Soc. vii, pp. 287–93. 1922.

(13) Woronin, M. Die Sklerotinienkrankheit der Vaccinienbeere. Mém. de l'Acad. de St Pétersbourg, Série 7, xxxvi. 1880.

(14) —— Die Sklerotinienkrankheit der gemeinen Traubenkirsche und der Ebersche. Mém. de l'Acad. de St Pétersbourg, Série 8, vol. ii, No. 1. 1895.

DESCRIPTION OF PLATE XVIII.

Fig. 1. Blotch on quince leaf caused by *Sclerotinia Cydoniae*.

Fig. 2 Infected quince shoot with wilting leaves. The conidial fructifications are seen as a whitish layer along the midrib and main veins.

1

2

SCLEROTINIA CYDONIAE

ON SOME FEATURES OF GROWTH AND REPRODUCTION IN SPORODINIA GRANDIS LINK.

(With 2 Text-figs.)

By Wilfrid Robinson, D.Sc.

THE work of Klebs (4, 5) on the connection between external conditions and the appearance of reproductive structures in fungi served to establish the fact of an antithesis between vegetative growth and reproductive activity. He found that differing external conditions led to vegetative growth, to the development of asexual or sexual reproductive structures. Klebs also pointed out that the external conditions operate upon the organism by inducing internal changes which find expression in the form of the reproductive structures. In many of the cases he studied the excess of organic compounds was thought to favour the appearance of sexual organs while an excess of nitrogen compounds favoured vegetative growth.

In the work of Klebs, and also in that of later investigators on similar lines, so far as I am aware, the nature of the internal changes occurring has not been precisely determined for any given fungus. The determination of such internal changes is obviously a matter of great difficulty, but in the course of an attempt to analyse experimentally some of these internal changes in *Pyronema confluens* (7) methods were tried which have given even more striking preliminary results with *Sporodinia*.

Sporodinia grandis Link*, as is well known, occurs in nature on the fruit-bodies of decaying agarics, and other higher Basidiomycetes. It grows readily, however, on culture media rich in sugars. The material used in this investigation was isolated and grown on malt-extract agar from a growth of the fungus found on a decaying sporophore of *Boletus*. *Sporodinia* is a characteristic member of the Mucorineae, possessing two types of reproductive structure, sporangia and zygospores.

In plate cultures on a suitable nutrient agar it grows for the most part superficially, spreading rapidly to the margin of the dish. When this margin is reached the fungus gives rise to aerial branches which then, according to the conditions of culture, produce sporangia or zygospores.

Klebs showed that on a good nutritive medium with a moderate supply of nitrogen and an abundance of sugar,

* It would appear (see *Journ. Bot.* LIII (1925), p. 303) that *Syzygites megalocarpus* (Ehrenb.) Fr. is the strictly legal name for this fungus, but as the name *Sporodinia grandis* Link is almost invariably used in recent physiological investigations it is adopted here.

sporangia were developed most readily in an atmosphere of 75–80 per cent. relative humidity and at humidities of from 90 to 100 per cent. only zygospores were produced. He regarded the transpiration of the fungus as the factor which determined whether zygospores or sporangia should be produced and he also demonstrated that carbohydrates and higher alcohols were specifically favourable to zygote production. Transpiration, or its relative rate, was regarded by Klebs as a stimulus which was active in liberating the morphogenic processes in reproduction. Minimal transpiration, according to this view, favoured zygote production, while a more active transpiration led to the development of sporangiophores. The aerial branch-systems which give rise to zygotes or sporangia were regarded by Klebs as morphologically homologous structures.

Brefeld (1), and more particularly his pupil Falck (2), worked on the relation of *Sporodinia* to external conditions and diverged from most of Kleb's (4) conclusions. Falck produced experimental evidence that the concentration of the medium is the dominating factor determining whether zygospores or sporangia shall arise. Neither Brefeld nor Falck, however, made due allowance for the possible effects of humidity, and on this account Klebs (5) regards many of their results as confirmatory of his conclusions.

In the present work, with the strain of the fungus used, it was generally possible, by following the methods described by Klebs to produce either type of reproductive structure at will. It should, however, be stated that prolonged culture, involving several transfers on an unfavourable medium, has been found to lead to a gradual diminution in the power of producing zygospores. Whilst the results obtained by Klebs have been repeated, the loss of reproductive vigour after prolonged culture may explain the divergence between the results of Klebs and Brefeld and Falck*.

Having found in *Pyronema confluens* (7) definite relations existing between growth activity and reproduction, tests were carried out to ascertain whether any such relations held in *Sporodinia*.

Methods.

For culture a liquid medium containing either 5 per cent. or 10 per cent. of malt extract was used. In each culture 25 c.c. of medium, contained in a 250 c.c. conical flask, was inoculated with a loopful of a suspension of spores.

Using series of such cultures the relations between the vegetative growth, the respiratory activity and the development

* Klebs (1902) has pointed out important differences in the strains of *Sporodinia* used by Brefeld and himself respectively

were studied under appropriate conditions. In the case of sporangial development, for instance, a series of 50 flasks was inoculated and incubated at 22° C. for two days. At the end of this time a vigorous growth of submerged mycelium had taken place in all the cultures. Ten of the cultures were then in turn attached to an apparatus for measuring the rate of respiration as given by CO_2 output, by the method employed by Osterhout (6) and his collaborators. This rate having been obtained the mycelial mat was, in each case, removed, washed five times with cold water on the filter paper and dried to constant weight at 60° C. The average weight of these ten mycelial mats was taken as a figure for one of the points on an average growth curve. The following day the same procedure was repeated for ten more cultures of the series. By this time, that is, on the third day of growth, the mycelium had produced a fine aerial felt over the whole surface of the culture. The mycelial mats were washed and dried as before and the average weight gave the second point on the growth curve. The same process was repeated on the fourth, sixth and tenth days, five points being thus obtained for the average growth curve of the series of cultures. The condition of the cultures was carefully noted each day so that the rate of respiration and of growth might if possible be correlated with morphological changes in the fungus. On the fifth day the first signs of sporangiophores were detected in more than half the cultures remaining.

The respiratory activity was calculated in terms of the volume of CO_2 per gram of mycelium per minute. This method is not an altogether satisfactory basis for estimating the respiratory activity of fungal cultures since with increasing age of the cultures there are increasing amounts of inert non-respiring matter in the cell walls and cell contents. It, however, was the best available under the conditions of the experiments. Further, the results cannot be seriously misleading on this account, since there was no doubt from the measurements that the absolute amounts of CO_2 liberated by a culture fall off with development.

Kidd, West and Briggs (3) have found that the "respiratory index" of the flowering plant *Helianthus annuus* shows similar falling off with age.

An average growth curve obtained by plotting the average weights against time is given in fig. 1. On the same figure is given a curve representing the respiratory activity obtained by plotting volume of CO_2 per gram of mycelium per minute against time. The condition of the culture in regard to the state of development of the sporangia is indicated on the same diagram. It is seen that the respiratory activity falls off from a high rate in the early stages of growth to a very low rate on the later days.

The growth curve, at first steep, gradually falls off from the fourth day and after the seventh day becomes negative owing to the autolysis of the fungal mat having set in.

The morphological development of the fungus showed marked correlation with these curves. On the fourth day, when the growth curve was beginning to flatten and the respiratory rate to fall off, the aerial hyphae which were the forerunners of the sporangia made their appearance. By the sixth day the sporangia were maturing, the growth curve had become flat and respiration had fallen to a very low rate. Presumably the

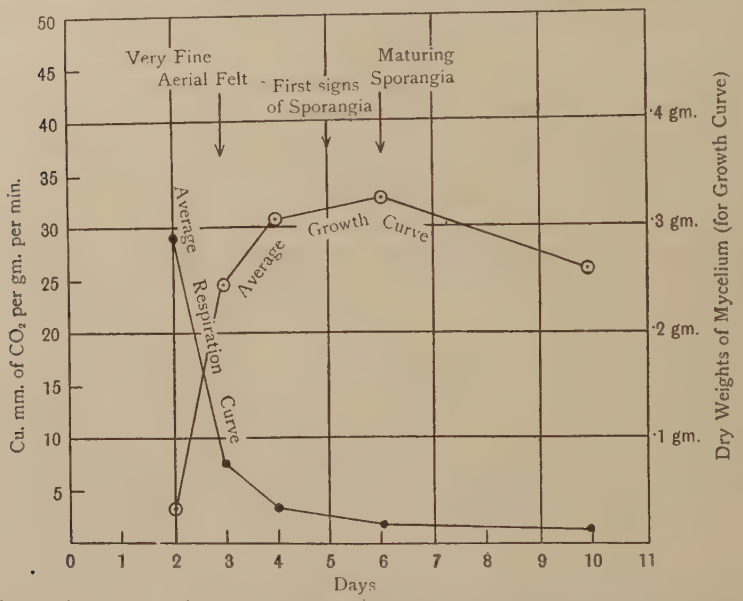

Fig. 1. Curves showing the average growth and average output of CO_2 due to respiration in cultures of *Sporodinia* grown under conditions favouring the development of sporangia.

medium was by this time becoming relatively exhausted. This question was not tested in the present series of experiments. It must be emphasised in regard to the results given in fig. 1 that no aerial hyphae made their appearance until the growth curve had begun to flatten and that the further falling off in the growth rate was accompanied by the appearance and subsequent development of the sporangia. The maturation of the latter was attended by an actual loss in dry weight owing to the respiration of the fungus on the exhausted medium.

The question might be raised as to whether the relations just described are not merely correlation effects dependent on the

development of the sporangia. In other words there is the possibility that the morphological changes associated with reproduction lead to the falling off in growth rate as measured by the increase in dry weight. That this is not so is indicated by the fact that no sign of reproductive structures has ever been seen in this work until the growth rate has begun to fall off. The nutritional factors involved in the slowing of the growth rate appear to be responsible for the internal changes which reach morphological expression during the development of sporangia. If the conditions of culture are so arranged that there is no falling off in the growth rate then no reproductive structures arise and little aerial mycelium is produced.

Zygospore Formation.

The corresponding relations to those described above were studied in similar series of flask cultures, which were given the appropriate conditions for zygospore formation. The cultures were grown at the ordinary temperature of the laboratory (*i.e.* about 15° C.) and the flasks were corked above the plugs in order to obtain the high humidity necessary for zygospore formation. Before making the estimations of the rates of respiration the accumulated CO_2 of the previous period of respiration was thoroughly flushed out by passing a stream of air through the flasks. The methods used were similar to those described above for the sporangial series, though the number of cultures was smaller.

The curves shown in fig. 2 give the general trend of the results. As before there is a falling off in the growth rate as measured by the dry weight of mycelium formed in a given time. This falling off in growth is accompanied, as before, by the appearance of aerial hyphae, but under the relatively more humid conditions some of these hyphae subsequently become zygosporic branch-systems. The growth rate continues to be reduced as zygospores appear, and finally during the maturation of the zygospores there is a net loss in weight due to the loss by respiration being greater than the intake of materials from the now exhausted medium. As in the case of the development of sporangia the rate of respiration*, as measured by the output of CO_2, has fallen to a low level before reproduction is initiated.

From the results given it appears that in the initiation of both types of reproductive structures in *Sporodinia* similar factors are at work. In both cases the reproductive bodies are, as Klebs pointed out, aerial structures arising on hyphal branches which grow away from the medium. It seems clear that the tendency

* In this case the respiration curves from three cultures of the series are given in place of the average respiration curve in fig. 1.

for the development of the aerial hyphae is the first visible expression of the reduction in the growth rate consequent on the exhaustion of the medium in nutrient materials. Whether the reproductive structures which then arise on these aerial hyphae are sporangia or zygospores depends on other factors of which, as Klebs has shown, the most important are the rate at which water is lost from the hyphae and the initial carbohydrate and nitrogen concentration of the medium. It must be noted, however, that even after the appearance of the aerial hyphae the conditions may inhibit the development of either type of reproductive structure. Considerable acidity in the medium or high temperatures have such inhibitory effects.

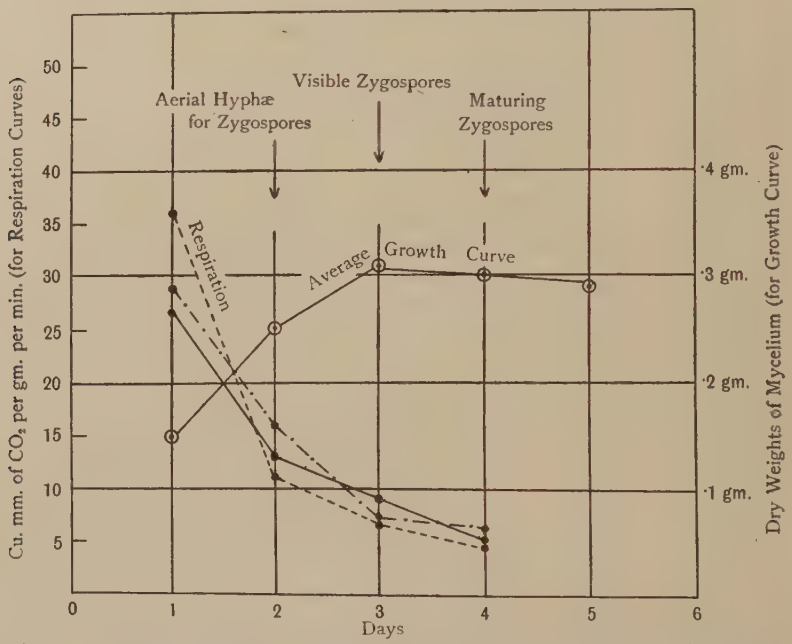

Fig. 2. Curves showing the average growth and the output of CO_2 due to respiration in cultures of *Sporodinia* grown under conditions favouring the development of zygospores.

In the further development of the aerial branch-systems into sporangiophores on the one hand, and zygosporic tufts on the other, important differences in the structure and contents of the hyphae soon become manifest. In the development of the sporangia the erect aerial hyphae are at first colourless and show considerable growth. The tips then begin to branch dichotomously and finally the young sporangia swell out and are cut off by septa. The pressure from below on the septum leads to

the bulging of the columella into each sporangium. Vacuolation takes place in the hyphae below the sporangia and transverse septa appear in the branches and main axis of the sporangiophore. Finally, as the spores are maturing within the sporangia, the sporangiophore becomes somewhat brown in colour owing to the deposition of a dark substance in the hyphal walls.

In the production of the zygosporic branches the aerial hyphae do not grow nearly as tall as in the case of the sporangial branches. The dichotomies are less frequent, the hyphae grow further after branching and taper at their extremities. The hyphae are more densely filled with protoplasmic contents than in the hyphae-forming sporangia and early become very dark in colour. The hyphal walls are much thicker and tests with iodine indicate the contents of the cells to be richer in glycogen than in the case of the sporangial hyphae. A very manifest protoplasmic streaming occurs during the development of the gametes in marked contrast to the vacuolation and septation which takes place in the development of the sporangiophores.

The early appearance of the black product in the zygosporic tufts is probably an important index of the differing metabolism of the hyphae of these tufts. The product appears first in the protoplasm and is deposited in the thickened walls of the hyphae, being especially abundant in the wall of the zygospore. Although a certain amount of browning occurs, this dark coloured substance does not appear in the same quantity in the sporangiophore, and it seems likely that in the development of the zygosporic branches a tyrosinase-like reaction resulting in the appearance of melanins is much more active than in the sporangial development. This question is being further investigated.

Concluding Remarks.

In the determination of the transition from purely vegetative growth to the development of either type of reproductive structure in *Sporodinia*, the primary factors appear to be the internal metabolic changes associated with a diminution of growth. The changes envisaged are, up to a point, common to both types of reproductive body and are manifested by the development of aerial hyphae. From this stage the course of the subsequent metabolic processes and the consequent morphological development are determined by the nature of the medium and the degree of humidity of the air over this*. If the medium has been relatively concentrated in carbohydrate and the humidity over the culture is high, then zygosporic tufts are developed. If, on the other hand, the concentration

* A definite sequence of physico-chemical causation is here thought of rather than the stimulus effects postulated earlier by Klebs.

of carbohydrate in the medium is relatively low and the humidity is below 80 per cent. then sporangial tufts arise. It is obvious that, in the first case, the thickened walls of the zygosporic hyphae and the richness of these in glycogen is correlated with the high concentration of sugars in the medium, surplus carbohydrates accumulating in the hyphae in the form of condensation products such as glycogen and wall substances. The appearance of melanins is less easily explained, but it is hoped that further work on the nitrogen metabolism of *Sporodinia* will throw light on this question.

It may here be suggested, however, that the relative exhaustion of the medium in nitrogen is probably the primary cause of the diminution in growth. This may be responsible for the changed direction of metabolism which is undoubtedly seen in the reproductive phase of the fungus.

The further analysis of the questions raised in a preliminary way in this paper is being carried forward, and it appears not unlikely that definite relationships between the metabolic processes and the different structures arising during the reproduction of *Sporodinia* may be established.

REFERENCES.

(1) Brefeld, O. Über die geschlechtlichen und ungeschlechtlichen Fruchtformen bei den copulierenden Pilzen. Schles. Gesell. f. Vaterländ. Kultur, 1900, p. 27. 1901.
(2) Falck, R. Die Bedingungen und die Bedeutung der Zygotenbildung bei *Sporodinia grandis*. Cohn. Beiträge zur Biol. der Pflanzen, VIII, Hft. 2, p. 213. 1901.
(3) Kidd, F., West, C. and Briggs, G. E. A quantitative analysis of the growth of *Helianthus annuus*. Part I. The respiration of the plant and its parts throughout the life-cycle. Proc. Roy. Soc. Lond. B. XCII, p. 368. 1921.
(4) Klebs, G. Zur Physiologie der Fortpflanzung einiger Pilze. 1. *Sporodinia grandis* Link. Jahrb. f. wiss. Bot. XXXII, p. 1. 1898.
(5) —— Über *Sporodinia grandis*. Bot. Zeit. L, p. 177. 1902.
(6) Osterhout, W. J. V. A method of studying respiration. Journ. Gen. Physiology, I, p. 17. 1918.
(7) Robinson, W. On the conditions controlling growth and reproduction in *Pyronema confluens*. Rept. Brit. Assn. (Toronto). 1924.
(8) —— The conditions of growth and development in *Pyronema confluens* Tul. Annals of Botany, pp. 1–28, 1926.

ADDITIONAL RECORDS OF CTENOMYCES SERRATUS EIDAM.

By R. W. Marsh, B.A., Research Assistant in Mycology in the University of Manchester.

Ctenomyces serratus Eidam was found in August, 1922, in three pots at the Botanic Garden, Cambridge. Two of the pots contained pine seedlings, the other, a young *Cistus*. Four

months previously these plants had undergone root inoculation with *Roesleria hypogoea* Thüm. et Pass. When examined, the pines were dead; the *Cistus* apparently healthy.

In December, 1922, root inoculations were made on rose, *Quercus alba* and *Cotoneaster* sp. with cultures of *Roesleria* derived from that previously used. In June, 1923, examination showed *Ctenomyces* present on all the inoculated roots.

In all the cases mentioned the *Ctenomyces* fructifications occurred clustered round the point of inoculation on the exterior of the root or in the soil in the immediate neighbourhood. The ascus stage only was found.

The pots contained ordinary potting soil, and as far as could be ascertained no particles of feathers were present, neither had any opportunity arisen for contact with feathers to take place.

In September, 1923, *Ctenomyces* was found in Queen's Cottage Grounds at the Royal Botanic Gardens, Kew, from whence it had been previously recorded by Professor E. S. Salmon. The fungus occurred in an area about 1 foot across beneath a chestnut tree. At this point the soil was covered with leaves and twigs more or less decayed, mixed with which were rotted feathers. The ascus fructifications were scattered indiscriminately through this *débris*, and occurred also in the uppermost 2 or 3 inches of soil. Search was made for the fungus at the same spot in June, 1924, but without success.

Single spore cultures were started from the ascospores of the Cambridge material, but as might be expected no indication has yet (1925) been found that *Roesleria* and *Ctenomyces* were in any but a chance association. From these cultures, however, conidiophores of two types (as figured by von Eidam) have originated—single hyphae, and clusters of hyphae repeatedly branched at right angles—the conidia being borne laterally in both types. The genetic connection of these conidial forms with the ascus stage has thus been established.

Von Eidam also describes a perennating stage in which the fungus forms a compact woolly mycelium bearing long, stiff, barbed *krallenhaken*, which, in his view, are of use in dispersing the fungus. This stage has not been seen in the course of these observations.

In culture, *Ctenomyces* has been found to grow on a variety of substrata. Vigorous cultures have resulted on Dox's agar, horse-dung agar, starch-asparagin-glucose agar, raisin gelatine, beerwort gelatine, plum-wood blocks and sterilised soil. On clean sterilised feathers growth was extremely meagre but the fungus grew well on feathers that were mixed with soil.

Von Eidam, Dangeard and Grove all describe the fungus as occurring on dirty and decaying feathers. Grove mentions that

it also occurs on soil. The material found at Cambridge occurred in the complete absence of feathers, a phenomenon previously recorded by Miss Lorrain Smith, who describes a gathering of *Ctenomyces* by the Rev. W. Eyre in Hampshire on decaying beech and other leaves. The same author refers to a fungus collected by Currey in 1854, upon fragments of dead leaves and sticks on very moist ground in woods, for which he suggested the new generic name of *Arthroderma*. It was subsequently named *Arthroderma Curreyi* by Berkeley and appears in Saccardo as *Illosporium Curreyi* (Berk.) Sacc. From Currey's figures it seems extremely probable that this fungus was *Ctenomyces serratus*.

Mr Ramsbottom informs me that Mr St John Marriott found the fungus on cabbage roots at Woolwich and that he himself has found it on roots of grasses at the edge of a herbaceous border at Richmond, Surrey.

From these records it would appear that the specialisation of *Ctenomyces* is not as strict as is usually stated. The cultural work would suggest that in the cases where the fungus is found on feathers it is there essentially as an epiphyte deriving little or no nourishment from them.

I have to express my gratitude to Miss E. M. Wakefield for supplying me with certain references, and my best thanks to Mr F. T. Brooks for his interest and help in these observations.

REFERENCES.

Berkeley, M. J. Outlines of British Fungology, p. 357. 1860.
Currey, F. Quart. Journ. Micros. Soc. II, p 241, Pl. IX, figs. 6–8. 1854.
Dangeard, P. Le Botaniste, X, pp. 86 and 97. 1907.
Eidam, E. von. Cohn's Beiträge, III, p 267, Pl. XII. 1880.
Grove, W. B. Journ. Bot. LX, p. 170. 1922.
Saccardo, P. A. Sylloge Fungorum, IV, p. 660. 1886.
Salmon, E. S. Journ. Quekett Micros. Club, Ser. 2, VII, p. 374. 1900.
Smith, A. Lorrain. Journ. Bot. XLI, p. 257, 1903; XLII, p. 55, 1904.
—— Trans. Brit. Mycol. Soc. II, p. 60. 1904.

NOTE.

CLADOCHYTRIUM MYRIOPHYLLI ROSTR.—A NEW BRITISH RECORD.

The material of the fungus, described briefly in this note, was collected by the late Dr R. C. Davie prior to 1915, and handed over to me for examination by Dr Malcolm Wilson. This fungus, which occurs on *Myriophyllum verticillatum* was certainly obtained in Scotland and it is very probable that it was from some part of Perthshire.

Cladochytrium Myriophylli was first described by Rostrup (Myk. Medd. IX, *Bot. Tidsskr.* XXVI, p. 305, 1904–5) and the life-

history was later worked out by Ferdinandsen and Winge and recorded in the same Danish *Journal* (XXIX, p. 305, 1908–9). Vestergren has transferred the species to the genus *Physoderma*.

In the Scottish material thick brownish tumours occurred on the stems. Underneath the brownish patches and distributed in the intercellular spaces of the parenchyma of the host were numerous big ellipsoidal to spherical spores, possessing thick brownish yellow walls. The size of the spores measured on the average about 30 μ across. In some cases, lying alongside the resting spores, were the remains of a large thin-walled cell, with appendages. These appendages are very probably the hyphal attachments and the cell itself is looked upon by some as the antheridium. The resting spores are filled with large globules of yellow oil.

Cladochytrium Myriophylli has not been previously recorded in Britain, but the allied species, *Physoderma Menyanthis* de Bary, is not uncommon and is found in East Lothian and other localities.

JOHN S. L. WALDIE.

Mycological Dept., University of Edinburgh.

PROCEEDINGS.

MEETING. UNIVERSITY COLLEGE, LONDON. *24th January.*

Miss E. M. Blackwell. An outline of the life history of *Phytophthora cactorum* Schroet.
Mr H. R. Briton-Jones. "Bark-Canker" and "Die-Back" of Fruit trees.
Mr J. Ramsbottom. Fragmenta Mycologica II.
Prof. E. S. Salmon. The Epidemic Appearance in England in 1924 of a "Downy Mildew" of the Hop.

MEETING. UNIVERSITY COLLEGE, LONDON. *21st March.*

Miss E. Green. The development of *Zygorhynchus*.
Mr W. F. Hanna. Sex in the genus *Coprinus*.
Mr. J. Ramsbottom. Fragmenta Mycologica III.
Dr M. C. Rayner. Sectoring in cultures of *Phoma radicis-Callunae* Rayn.
Miss A. L. Smith. 1. Notes on Myxobacteriaceae. 2. Templeton's drawings of Fungi and Lichens.

SPRING FORAY, TINTERN. *24th—28th April.*

SPRING FORAY FOR LONDON STUDENTS, BOX HILL. *9th May*

PHYTOPATHOLOGICAL MEETING, CAMBRIDGE. *4th July.*

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Smith, Miss Annie Lorrain, F.L.S., 20, Talgarth Road, West Kensington, London, W. 14, (1899). (1924.)

Thaxter, Professor R., 7, Scott St., Cambridge, Mass., U.S.A. (1920.)

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8. Bagchee, Mr K., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1920.)
9. Baker, Mr Thomas, 191, Lees Road, Oldham. (1923.)
10. Barnes, Mr B., B.Sc., Birkbeck College, Breams Buildings, Chancery Lane, London, E.C. 4. (1922.)
11. Barnett, Miss E. C., B.Sc., Botany Department, Marischal College, Aberdeen. (1921.)
12. Barr, Rev. Robert, T.D., M.A., The Manse, Neilston, Renfrewshire. (1918.)
13. Barrington, Dr F. J. F., University College Hospital, Medical School, University Street, London, W.C. 1. (1901.)
14. Bartlett, Mr A. W., M.A., B.Sc., Dept. of Botany, Armstrong College, Newcastle-on-Tyne. (1920.)
15. Batten, Miss L. S., Ph.D., Botanical Department, British Museum, Cromwell Road, South Kensington, London, S.W. 7. (1921.)
16. Beaumont, Mr A., Seale-Hayne Agricultural College, Newton Abbot, Devon. (1924.)

17. Bewley, Mr W. F., D.Sc., Experimental and Research Station, Cheshunt, Herts. (1922.)
18. Biffen, Professor Sir R. H., M.A., F.R.S., 136, Huntingdon Road, Cambridge. (1899.)
19. Birmingham Natural History and Philosophical Society, c/o Mr J. W. Moore, 151, Middleton Hall Road, King's Norton, Birmingham. (1920.)
20. Bisby, Mr Guy R., Ph.D., Manitoba Agricultural College, Winnipeg, Canada. (1921.)
21. Blackman, Professor V. H., M.A., F.R.S., Imperial College of Science, South Kensington, London, S.W. 7. (1900.)
22. Blackwell, Miss Elsie M., M.Sc., Botanical Department, Royal Holloway College, Englefield Green, Surrey. (1917.)
23. Blagden, Mr Charles Otto, 57, Earl's Court Square, London, S.W. 5. (1910.)
24. Bloom, Mr James Harvey, M.A., 31, Veronica Road, Upper Tooting, London, S.W. 17. (1915.)
25. Bolas, Mr B. D., 60, Grove Park Terrace, Chiswick, London, W. 4. (1924.)
26. Borthwick, Mr A. W., D.Sc., Forestry Commission, 22, Grosvenor Gardens, London, S.W. 1. (1911.)
27. Bose, Professor S. R., M.A. (Calc.), F.L.S., Carmichael Medical College, 1, Belgachia Road, Calcutta, India. (1921.)
28. Boston, The Mycological Club, c/o Miss Jennie F. Conant, 26, Prospect Street, Melrose, Mass., U.S.A. (1906.)
29. Boyd, Mr D. A., St Clair, Caledonia Road, Saltcoats, N.B. (1906.)
30. Bracher, Miss R., M.Sc., Bishop Wordsworth's School, Salisbury. (1922.)
31. Braid, Major K. W., B.A., B.Sc., B.Sc. (Agric.), A.I.C., West of Scotland Agricultural College, Glasgow. (1922.)
32. Brazier, Mr E., Brook Road, Oldswinford, Stourbridge. (1921.)
33. Breeze, Miss B. M., B.Sc., School of Agriculture, Cambridge. (1922.)
34. Brett, Miss M., M.Sc., Northern Polytechnic, Holloway Road, London, N. 7. (1921.)
35. Brierley, Mr W. B., D.Sc., F.R.A.I., F.L.S., Institute of Plant Pathology, Rothamsted Experimental Station, Harpenden, Herts. (1919.)
36. British Museum, The Trustees of, Cromwell Road, South Kensington, London, S.W. 7. (1914.)
37. Briton-Jones, Mr H. R., B.Sc., D.I.C., A.R.C.Sc., Research Station, Long Ashton, Bristol. (1923.)
38. Brittlebank, Mr C. C., Produce Offices, 607, Flinders Street, Melbourne, Victoria, Australia. (1921.)
39. Brooks, Mr F. T., M.A., F.L.S., The Botany School, Cambridge. (1907.)

40. Brooks, Mr R. St John, M.D., M.A., D.P.H., etc., Lister Institute, Chelsea Gardens, London, S.W. 1. (1921.)
41. Brown, Mr W., M.A., D.Sc., Imperial College of Science, South Kensington, London, S.W. 7. (1922.)
42. Brown University, Library, East Side Station, Providence, R.I., U.S.A. (1920.)
43. Bruxelles, Jardin Botanique de l'État, c/o M. P. van Aerdschot. (1911.)
44. Bryce, Mr G., D.Sc., Director, Department of Agriculture, Rabaul, New Guinea. (1915.)
45. Buckley, Mr W. D., 2, Curzon Street, Slough. (1916.)
46. Buddin, Mr Walter, M.A., Laboratory of Plant Pathology, University College, 7, Redlands Road, Reading. (1921.)
47. Buller, Professor A. H. R., D.Sc., Ph.D., F.R.S.C., University of Manitoba, Winnipeg, Canada. (1911.)
48. Bunker, Mr H. J., B.A., St Olave's, Churchfield Road, Poole, Dorset. (1925.)
49. Bunting, Mr R. H., F.L.S., Agricultural Department, Aburi, Gold Coast Colony, W. Africa. (1921.)
50. Bunyard, Capt. G. N., F.L.S., 25, Bower Mount Road, Maidstone, Kent. (1920.)
51. Burger, Dr O. F., Agricultural Experiment Station, Gainesville, Florida, U.S.A. (1925.)
52. Burr, Mr S., The Agriculture Department, The University, Leeds. (1924.)
53. Butcher, Mr R. W., Fisheries Research Station, Alresford, Hants. (1921.)
54. Butler, Mr E. J., C.I.E., D.Sc., M.B., F.L.S., Imperial Bureau of Mycology, 17, Kew Green, Kew, Surrey. (1920.)
55. Butler, Mr R. R., M.Sc., A.I.C., 55, Seymour Road, Hornsey, London, N. 8. (1924.)
56. Cadman, Miss E. J., 22, Eildon Street, Edinburgh. (1921.)
57. Cambridge, The Botany School. (1920.)
58. Cape Town, Union of South Africa. The Mycologist (91410), Department of Agriculture. (1922.)
59. Carr, Professor J. W., M.A., University College, Nottingham. (1896.)
60. Carrothers, Mr E. N., 145, Stranmillis Road, Belfast, N. Ireland. (1925.)
61. Cartwright, Mr K. St G., B.A., c/o Dr Granger, Little Milton, Wallingford, Oxon. (1913.)
62. Castellani, Professor Aldo, C.M.G., M.D., 33, Harley Street, London, W. 1. (1922.)
63. Cayley, Miss Dorothy M., John Innes Horticultural Institute, Mostyn Road, Merton, Surrey. (1913.)
64. Charles, Mr J. H. V., 14, Fullarton Place, Stevenston, Ayrshire. (1922.)

65. Chaudhuri, Mr H., M.Sc., Ph.D., Botanical Department, University of the Panjab, Lahore, India. (1920.)
66. Cheel, Mr Edwin, Botanic Gardens, Sydney, New South Wales, Australia. (1919.)
67. Cheesman, Mr W. Norwood, J.P., F.L.S., The Crescent, Selby, Yorks. (1896.)
68. Clarke, Miss H., M.Sc., 45, Beaconsfield Road, Seaforth, Liverpool. (1917.)
69. Clarke, Mr J. Jackson, 25, Norfolk Road, London, N.W. 8. (1920.)
70. Cleland, Mr J. Burton, M.D., Professor of Pathology, University of Adelaide, South Australia. (1918.)
71. Collett, Mr R. Leslie, M.A., 12, Hereford Mansions, Bayswater, London, W. 2. (1921.)
72. Collins, Miss Florence, The School of Gardening, Clapham, nr. Worthing, Sussex. (1920.)
73. Cook, Mr W. R. I., Priory Lodge, Newlands Park, Sydenham, London, S.E. 26. (1924.)
74. Cooper, Miss Charlotte A., California Lane, Bushey Heath, Herts. (1911.)
75. Copenhagen, Universitets-Bibliothek, c/o P. Haase and Søn, Løvstraede 8, København K. (1923.)
76. Cornell University, The Library, New York State College of Agriculture, Ithaca, N.Y., U.S.A. (1920.)
77. Corner, Mr E. J. H., Sidney Sussex College, Cambridge. (1924.)
78. Corner, Mr E. M., M.A., F.R.C.S., B.Sc., Woodlands Park, Great Missenden, Bucks. (1920.)
79. Cotton, Mr Arthur D., F.L.S., Keeper, Herbarium, Royal Botanic Gardens, Kew, Surrey. (1902.)
80. Crow, Mr W. B., M.Sc., F.L.S., Botanical Department, University College, Cardiff. (1921.)
81. Cunningham, Mr G. H., Biological Laboratory, 71, Fairlie Terrace, Kilburn, Wellington, New Zealand. (1922.)
82. Curtis, Miss Kathleen M., M.A., D.Sc., D.I.C., F.L.S., Mycologist, Biological Department, Cawthron Institute of Scientific Research, Nelson, New Zealand. (1917.)
83. Cutting, Mr E. M., M.A., F.L.S., Botanical Department, University College, Gower Street, London, W.C. 1. (1920.)
84. Darbishire, Professor O. V., B.A., Ph.D., F.L.S., The University, Bristol. (1913.)
85. Das, Mr Kedarnath, C.I.E., M.D., Principal, Carmichael Medical College, 1, Belgachia Road, Calcutta, India. (1922.)
86. Dastur, Mr J. F., M.Sc. (Bomb.), Imperial Agricultural Research Institute, Pusa, Bihar and Orissa, India. (1920.)
87. Davies, Mr D. W., B.Sc., Adviser in Mycology, Agricultural Buildings, University College of Wales, Aberystwyth. (1923.)

88. Davis, Mr J. Jefferson, B.S., M.D., University of Wisconsin, Madison, Wis., U.S.A. (1921.)
89. Day, Mr E. Metcalfe, Rowan Cottage, Minchinhampton, Glos. (1921.)
90. Dickinson, Mr S., 3, The Warren, Lillington, Leamington Spa. (1921.)
91. Dickson, Professor B. T., B.A., Ph.D., Macdonald College, St Anne de Bellevue, Quebec, Canada. (1923.)
92. Dowson, Mr W. J., M.A., F.L.S., Royal Horticultural Soc. Gardens, Wisley, Ripley, Surrey. (1920.)
93. Doyle, Professor J., M.Sc., University College, Dublin. (1925.)
94. Duke, Miss M. M., B.Sc., Herbarium, Royal Botanic Gardens, Kew, Surrey. (1924.)
95. Duncan, Mr J. B., 6, Summerhill Terrace, Berwick-on-Tweed. (1923.)
96. Edwards, Mr W. H., Curator, The Museum, Birmingham. (1896.)
97. Elliot, Rev. E. A., The Moat, Yoxall, Burton-on-Trent. (1923.)
98. Elliott, Mrs J. S. Bayliss, D.Sc. (B'ham), B.Sc. (Lond.), Arden Grange, Tanworth-in-Arden, Warwickshire. (1911.)
99. Elliott, Mr W. T., D.D.S., L.D.S., F.Z.S., F.L.S., Arden Grange, Tanworth-in-Arden, Warwickshire. (1913.)
100. Ellis, Mr David, D.Sc., Ph.D., F.R.S.E., Royal Technical College, Glasgow. (1923.)
101. Ellis, Mr E. H., Department of Botany, British Museum (Natural History), Cromwell Road, South Kensington, London, S.W. 7.
102. Engledow, Mr F. L., School of Agriculture, Cambridge. (1922.)
103. Essex Field Club, c/o Mr Percy Thompson, F.L.S., Essex Museum of Natural History, Romford Road, Stratford, London, E. 15. (1919.)
104. Eyre, Miss J. C., Ipplepen, Newton Abbot, Devon. (1915.)
105. Fenton, Mr E. W., M.A., B.Sc., F.L.S., Botanical Department, Seale Hayne Agricultural College, Newton Abbot, Devon. (1920.)
106. Finlayson, Mr Raymond A., F.L.S., 9, Addison Road, Bedford Park, London, W. 4. (1910.)
107. Fry, Miss E. J., "Hazelhurst," Pear Tree Avenue, Bitterne, Southampton. (1923.)
108. Fry, Miss P., B.Sc., A.R.C.S., Botanical Laboratories, The University, Liverpool. (1922.)
109. Gadd, Mr C. H., B.Sc., Royal Botanic Gardens, Peradeniya, Ceylon. (1921.)
110. Gandy, Mr Wallace, 78, Egmont Road, Surrey. (1923.)
111. Gardner, Capt. Frederic, c/o Lloyd's Bank, Jersey, C.I. (1898.)
112. Garside, Mr S., M.Sc., F.L.S., Botanical Department, Bedford College, Regent's Park, London, N.W. 1. (1922.)

113. Gates, Professor R. R., B.Sc., Ph.D., F.L.S., King's College, Strand, London, W.C. 2. (1921.)
114. Gilbert, M. E., Docteur en Pharmacie, 6, rue de Laos, Paris (15e). (1924.)
115. Gilbert, Dr E. M., Botanical Department, University of Wisconsin, Madison, Wis., U.S.A. (1922.)
116. Gilchrist, Miss Grace G., B.Sc., Botanical Department, The University, Bristol. (1921.)
117. Gorman, Mr M. J., A.R.C.Sc.I., College of Science, Upper Merrion Street, Dublin. (1925.)
118. Gossling, Mrs W. L., 20, Carlton Hill, London, N.W. 8. (1922.)
119. Gough, Mr G. C., B.Sc., A.R.C.S., Ministry of Agriculture, Birmingham. (1923.)
120. Gould, Mr F. G., Elmhurst, Church Hill, Loughton, Essex. (1918.)
121. Gould, Mr N. G., Royal Horticultural Soc. Gardens, Wisley, Ripley, Surrey. (1922.)
122. Green, Col. C. Theodore, A.M.S., M.R.C.S. (Eng.), L.R.C.P. (Lond.), F.L.S., 31, Shrewsbury Road, Birkenhead. (1901.)
123. Green, Miss E., 9, Brunswick Square, London, W.C. (1925.)
124. Green, Mr E. Ernest, F.Z.S., F.E.S., Way's End, Camberley, Surrey. (1917.)
125. Grinling, Mr C. H., B.A., 71, Rectory Place, Woolwich, S.E. 18. (1913.)
126. Gwynne-Vaughan, Professor Dame Helen, D.Sc., LL.D., F.L.S., 93, Bedford Court Mansions, London, W.C. 1. (1906.)
127. Haas, Mr P., D.Sc., Ph.D., F.C.S., University College, Gower Street, London, W.C. 1. (1921.)
128. Hadden, Mr Norman G., Underway, West Porlock, Somerset. (1911.)
129. Hanna, Mr W. F., M.Sc., University of Alberta, Edmonton, Alberta, Canada. (1925.)
130. Hansford, Mr C. G., B.A., Microbiologist, Department of Agriculture, Jamaica. (1921.)
131. Hare, Mr J. G., Molteno Institute of Parasitology, Cambridge. (1924.)
132. Harris, Mr R. V., B.Sc., Research Station, East Malling, Kent. (1924.)
133. Harvard University Library, Cambridge, Mass., U.S.A. (1923.)
134. Harvey, Mrs Cecily D., Barwick in Elmet Rectory, nr. Leeds. (1910.)
135. Hasluck, Miss I. E., Green Hill Park, New Barnet, Herts. (1922.)
136. Hastings, Mr Somerville, M.S., F.R.C.S., 43, Devonshire Street, Portland Place, London, W. 1. (1913.)

137. Hemmi, Mr Takewo, Phytopathological Institute, Dept. of Agriculture, Kyoto Imperial University, Kyoto, Japan. (1923.)
138. Henry, Professor A., M.A., L.R.C.P. (Edinb.), M.R.I.A., V.M.H., College of Science, Upper Merrion Street, Dublin. (1925.)
139. Hildyard, Mr F. W., 14, Lambridge, Bath. (1913.)
140. Hiley, Mr Wilfred E., M.A., F.L.S., Research Institute, School of Forestry, Oxford. (1913.)
141. Hoare, Mr A. H., 111, Blenheim Gardens, Wallington, Surrey. (1922.)
142. Hoggan, Miss I. A., 28 A, Leinster Terrace, Lancaster Gate, London, W. 2. (1923.)
143. Holden, Mr H. S., D.Sc., F.L.S., Botanical Department, University College, Nottingham. (1923.)
144. Honolulu, The Library, Experiment Station, S.P.A., Box 411, Hawaii. (1920.)
145. Horne, Mr A. S., D.Sc., F.L.S., F.G.S., Botanical Department, Imperial College of Science, South Kensington, London, S.W. 7. (1921.)
146. Howard, Mr H. J., F.R.M.S., "Lingfield," 6, College Road, Norwich. (1918.)
147. Hughes, Mr G. C., Chesterton, Bicester, Oxon. (1898.)
148. Humphrey, Mr C. J., Laboratory of Forest Pathology, Old Soils Building, University of Wisconsin, Madison, Wis., U.S.A. (1921.)
149. Hunter, Mr C., M.Sc., Botanical Department, The University, Bristol. (1921.)
150. Hurrell, Mr H. E., 25, Regent Street, Great Yarmouth. (1921.)
151. Hyde, Mr H. A., B.A., National Museum of Wales, Cardiff.
152. Imperial College of Tropical Agriculture, Trinidad, B.W.I. (1921.)
153. Iowa, Library, State University of, Iowa City, Iowa, U.S.A. (1923.)
154. Issatchenko, Professor B. L., Directeur du Jardin Botanique, Petrograd, Russia. (1923.)
155. Jaczewski, Professor Arthur de, Director, Institute of Mycology, and Phytopathology, Perspective Anglaise 29, Petrograd, Russia. (1922.)
156. John Innes Horticultural Institute, Mostyn Road, Merton, Surrey. (1924.)
157. Johnson, Mr J. W. Haigh, M.Sc., F.I.C., F.L.S., Walton, nr. Wakefield. (1919.)
158. Johnstone, Mr R. B., 134, Cambridge Drive, Glasgow. (1908.)
159. Jones, Mr G. H., B.A., Mycologist, Department of Agriculture, Ibadan, S. Nigeria. (1922.)
160. Jones, Mr Robert Fowler, Trinity House, Denton Road, Ilkley, Yorkshire. (1918.)

161. Jørstad, Mr Ivar, Statsmykolog, Botanisk Museum, Christiania, Norway. (1923.)
162. Keef, Miss Phoebe, Mortimer Lodge, Wimbledon Park, London, S.W. 17. (1921.)
163. Keilin, Dr D., Molteno Institute of Parasitology, Cambridge. (1922.)
164. Keissler, Dr Karl, Direktor d. Botanische Abteilung, Naturhistorisches Museum, Burgring 7, Wien 1/1. (1924.)
165. Kelly, Dr Howard A., 1418, Eutaw Place, Baltimore, Md., U.S.A. (1921.)
166. Kendall, Miss O., Ministry of Agriculture, Pathological Laboratory, Milton Road, Harpenden, Herts. (1921.)
167. Kew, The Library, Royal Botanic Gardens. (1921.)
168. Kidd, Mrs Franklin, The Botany School, Cambridge. (1919.)
169. Kirby, Mr E. E., B.A., Grafton House, Oxford Street, Norwich. (1924.)
170. Knight, Mr H. H., M.A., The Lodge, All Saints' Villas, Cheltenham. (1914.)
171. Knowles, Miss M. C., M.R.I.A., Natural History Museum, Dublin. (1925.)
172. Krieger, Mr L. C. C., 2114, N. Calvert Street, Baltimore, Md., U.S.A. (1921.)
173. Kulkarni, Mr G. S., M.Ag., Assistant Professor of Mycology, Agricultural College, Poona, India. (1922.)
174. Lampitt, Mr L. H., D.Sc., F.I.C., 33, Roxborough Park, Harrow-on-the-Hill, Middlesex. (1925.)
175. Latter, Miss Joan, Botanical Department, King's College, Strand, London, W.C. 2. (1923.)
176. Leicester, The Museum, City of Leicester. (1923.)
177. Lewis, Professor F. J., D.Sc., University of Alberta, Edmonton, Alberta, Canada. (1924.)
178. Line, Mr James, M.A., School of Agriculture, Cambridge. (1921.)
179. Linnean Society, The, Burlington House, Piccadilly, London, W. 1. (1919.)
180. Lloyd, Mr C. G., The Lloyd Library and Museum, 224, West Court Street, Cincinnati, Ohio, U.S.A. (1907.)
181. Lowndes, Mr A. G., M.A., Marlborough College, Marlborough, Wilts. (1922.)
182. MacCullum, Mrs B. D., M.A., D.Sc., F.L.S., c/o Professor MacCallum, Department of Pathology, University of Melbourne, Melbourne, Victoria, Australia. (1921.)
183. Mackenzie, Miss A. D., Research Station, East Malling, Kent. (1921.)
184. Mackenzie, Mr D., Afton, Busby, N.B. (1900.)
185. Maire, M. René, D.Sc., Professeur à la Faculté des Sciences de l'Université, Algers, Algeria. (1907.)

186. Maitland, Mr T. D., Government Botanist, Department of Agriculture, Kampala, Uganda. (1916.)
187. Maltby, Mr G. C., 14, Northwick Road, Evesham.
188. Marmont, Mr Basil P., Windsoredge House, Inchbrook, nr. Woodchester, Gloucestershire. (1908.)
189. Marriott, Mr St John, 37, Owenite Street, Abbey Wood, London, S.E. 2. (1920.)
190. Marsh, Mr R. W., B.A., Botanical Department, The University, Manchester. (1923.)
191. Mason, Mr E. W., M.A., M.Sc., Imperial Bureau of Mycology, 17, Kew Green, Kew, Surrey. (1921.)
192. Mason, Mrs E. W., Suffield House, Paradise Road, Richmond, Surrey. (1922.)
193. Mason, Mr F. A., F.R.M.S., M.S.P.A., The Laboratory, 3, Queen's Square, Leeds. (1912.)
194. Mason, Mr F. R., Assistant Mycologist, Department of Agriculture, Kuala Lumpur, Federated Malay States. (1921.)
195. Matthews, Mr J. R., M.A., F.L.S., Royal Botanic Gardens, Edinburgh. (1921.)
196. McDonald, Mr J., B.Sc., Mycologist, Department of Agriculture, Nairobi, Kenya Colony. (1923.)
197. McDougall, Professor W. B., University of Illinois, Urbana, Ill., U.S.A. (1921.)
198. McFarland, Mr Frank T., Ph.D., Department of Botany, University of Kentucky, Lexington, Ky., U.S.A. (1924.)
199. McIver, Mr D. G., Regent Court, Headingley, Leeds. (1924.)
200. McLean, Professor R. C., M.A., D.Sc., F.L.S., Botanic Department, University College, Cardiff. (1922.)
201. Mehta, Professor K. C., Ph.D., Department of Biology, Agra College, Agra, U.P., India. (1921.)
202. Melvill, Mr J. Cosmo, M.A., D.Sc., F.L.S., Meole Brace Hall, Shrewsbury. (1922.)
203. Menzies, Mr James, 117, Scott Street, Perth. (1917.)
204. Meulenhoff, Dr J. S., President, Dutch Mycological Society, Diezerstraat, Zwolle, Holland. (1921.)
205. Millard, Mr W. A., B.Sc., The Agriculture Department, The University, Leeds. (1924.)
206. Missouri, The Botanical Garden, St Louis, Mo., U.S.A. (1902.)
207. Miyabe, Dr Kingo, Professor of Botany, Hokkaido Imperial University, Sapporo, Japan. (1919.)
208. Montague, Mrs A., Penton, Crediton, N. Devon. (1898.)
209. Moore, Miss E. S., Ph.D., c/o the Secretary, Dept. of Agriculture, Pretoria. (1923.)
210. Moore, Mr W. C., The Botany School, Cambridge. (1922.)
211. Morris, Mr L. E., The Shirley Institute, Didsbury, Manchester. (1924.)

212. Moss, Professor C. E., M.A., D.Sc., F.R.G.S., F.L.S., The University, P.O. Box 1176, Johannesburg, S. Africa. (1923.)
213. Mottram, Miss W. E., B.Sc., Horton Lane, Epsom, Surrey. (1925.)
214. Mundkur, Mr B. B., M.A., Cotton Research Laboratory, Government Farm, Dharwar, India. (1924.)
215. Murphy, Mr P. A., Sc.D., A.R.C.Sc.I., M.R.I.A., Plant Diseases Division, College of Science, Dublin. (1924.)
216. Murray, Mr G. H., F.E.S., Papuan Government Service, Port Moresby, Papua, British New Guinea. (1921.)
217. Murrell, Major Percy J., O.B.E., F.R.M.S., "Littlecroft," Orpington, Kent. (1923.)
218. Muskett, Mr A. E., Queen's University, Belfast, N. Ireland. (1923.)
219. Nagpur, The Mycologist to the Government, C.P., India. (1924.)
220. Nattrass, Mr R. M., B.Sc. (Agric.), Research Station, Long Ashton, Bristol. (1925.)
221. Nebraska, The Library, University of, Lincoln, Nebraska, U.S.A. (1924.)
222. Nederlandsche Mycologische Vereeniging, c/o H. A. A. van der Lek, Zoomweg 10, Wageningen, Holland. (1920.)
223. Newcastle-upon-Tyne, Literary and Philosophical Society, c/o H. Richardson, Librarian. (1902.)
224. Newman, Mr Leslie, M.A., F.I.C., F.L.S., Dip. Agr. Cantab., St Catharine's College, Cambridge. (1906.)
225. Newton, Mr W. C. F., B.Sc., John Innes Horticultural Institute, Mostyn Road, Merton, Surrey. (1922.)
226. New York Botanical Garden, Bronx Park, New York, U.S.A. (1904.)
227. Nicholson, Mr W. E., F.L.S., 50, St Anne's Crescent, Lewes. (1913.)
228. Noel, Miss E. F., F.L.S., 37, Moscow Court, Queen's Road, London, W. 2. (1913.)
229. North Carolina, Library, University of, Chapel Hill, North Carolina, U.S.A. (1920.)
230. Nursery and Market Garden Industries' Development Society, Ltd., Experimental and Research Station, Cheshunt, Herts. (1922.)
231. O'Connor, Mr P., B.Sc., A.R.C.Sc.I., College of Science, Upper Merrion Street, Dublin. (1925.)
232. Ogilvie, Mr L., M.A., M.Sc., Department of Agriculture, Agricultural Station, Paget East, Bermuda. (1922.)
233. Oke, Mr Alfred William, B.A., F.G.S., F.L.S., 32, Denmark Road, Hove, Sussex. (1908.)
234. Oldham, Mr C. H., Ivy Dene, Chandler's Ford, Southampton. (1923.)

235. Ontario Agricultural College Library, Guelph, Ontario, Canada. (1920.)
236. Osborn, Professor T. G. B., M.Sc., Adelaide University, Adelaide, South Australia. (1910.)
237. Overeem, Dr C. van, c/o Martinus Nijhoff, Lange Voorhout 9, 's-Gravenhage, Holland. (1920.)
238. Page, Miss W. M., M.Sc., 19, Ledam Buildings, Bourne Estate, Holborn, London, E.C. 1. (1921.)
239. Pan, Mr T. C., M.B., Ch.B., Avondale, Lenzie, Glasgow. (1925.)
240. Parke, Davis & Co., Librarian, Research Department, Detroit, Mich., U.S.A. (1920.)
241. Paul, The Very Rev. David, D.D., LL.D., 53, Fountainhall Road, Edinburgh. (1899.)
242. Paulson, Mr Robert, F.L.S., F.R.M.S., Glenroy, Cecil Park, Pinner, Middlesex. (1918.)
243. Peacock, Dr H. G., The Lawn, Torquay. (1896.)
244. Pearson, Mr Arthur A., F.L.S., 59, Southwark Street, London, S.E. 1. (1911.)
245. Peck, Mr A. E., Tosti, 20, Avenue Road, Scarborough. (1918.)
246. Peklo, Dr Jaroslav, Professor of Applied Botany, Bohemian Technical University, Charles Square, Prague II. (1924.)
247. Peltereau, M. E., Notaire honoraire, Vendôme, Loir-et-Cher, France. (1909.)
248. Perthshire Society of Natural Science, c/o James Winter (Hon. Treasurer), 35, George Street, Perth. (1919.)
249. Petch, Mr T., B.A., B.Sc., 24, Grove Avenue, Norwich. (1911.)
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355. Wormald, Mr H., D.Sc., A.R.C.S., Research Station, East Malling, Kent. (1921.)

RULES.

Society's name and objects.

1. The Society shall be called "The British Mycological Society," and its object shall be the study of Mycology in all its branches.

Members of Society.

2. The Society shall consist of Honorary Members, Foundation Members and Ordinary Members; the number of Honorary Members shall be limited to 20, and that of Foundation Members to 100*, but the number of Ordinary Members shall be unlimited.

Honorary Members.

3. Honorary Members shall be persons of pre-eminence in Mycology, or who have rendered special service to the Society.

Foundation Members.

4. Foundation Members shall be those Members or Societies who joined the Society previous to the limit of 100 Members having been attained*.

Officers.

5. The Officers of the Society shall consist of a President, one or more Vice-Presidents, Treasurer, Secretaries, and Editor or Editors. They shall be elected annually at the Annual General Meeting of the Society.

Government of Society.

6. The government of the Society shall be vested in a Council, which shall consist of the President and other Officers for the time being, together with two or more other Members who shall be elected annually at the General Meeting, and one-half of whom shall retire each year and not be eligible for immediate re-election. The Members to retire shall be those who have been longest in office or, in case of equality, shall be determined by ballot. Ex-Presidents are *ex officio* Members of the Council.

Every Meeting of the Council shall be duly summoned by the Hon. Secretary by at least seven days' notice in writing to each Member of the Council.

* The limit of 100 Foundation Members was reached 22nd Oct. 1903.

Period of Office.

7. The Officers and Council shall hold office as from the 1st of January following their election.

Election of Members.

8. Honorary Members shall only be elected at a Meeting of the Society by a majority of the Members then present.

All Ordinary Members shall be proposed and seconded respectively by existing Members, who shall sign a certificate (see appendix) of recommendation, one at least of the proposers so certifying from personal knowledge. Every candidate for election shall sign an undertaking to abide by the Rules if elected (see appendix). They shall be elected by a majority of the Members present at any meeting of the Society or by the President and Officers of the Society.

Subscription.

9. All Ordinary Members and Societies shall pay an annual subscription of one pound, and Foundation Members five shillings, due on the 1st of January in each year. Honorary Members shall be exempt from any annual subscription.

Any Member wishing to retire from the Society shall give notice to the Hon. Secretary or Treasurer in writing before the 1st of December of the previous year.

Meetings.

10. The Society shall hold one or more Meetings annually, at a place and time determined by the Members at the preceding Annual General Meeting, or by the Council. The Annual General Meeting for the election of Officers and the transaction of other business shall coincide with the Autumn Foray.

Accounts.

11. At the Annual General Meeting of the Society in each year the Hon. Treasurer shall present duly audited accounts.

Alteration of Rules.

12. The Rules shall not be altered except by a two-thirds majority of the Members present at an Annual General Meeting. A printed copy shall be sent to every Member of the Society on election, and in the event of alteration to all Members.

APPENDIX.

Form of proposal for Ordinary Membership of the British Mycological Society.

. . . . . .

of . . . . . .

. . . . . .

being desirous of becoming an Ordinary Member of the British Mycological Society, we, the undersigned Members of the Society, certify that we consider h to be a desirable Member of the Society, and beg to recommend h for election.

Dated this . day of 19

. . . . . (From personal knowledge).

Certificate to be signed by the Candidate.

I hereby certify that I desire to become an Ordinary Member of the British Mycological Society and that I will abide by the Rules if elected.

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